ABSTRACT

Title of dissertation: ESSAYS ON MULTIPLE EXCHANGE RATE SYSTEMS

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This dissertation measures the impact of multiple exchange rate systems on economic performance and on net capital flows in developing countries. The literature on the effectiveness of capital controls has some problems. Two of them are that it often ignores the endogeneity of capital controls, and that most of the evidence is dominated by some country specific studies. This dissertation fills this gap. It uses a multicountry panel to quantify the effects of parallel rates in the economy, but in doing so it explicitly models the endogeneity of multiple exchange rates. The dissertation is structured as follows. Chapter 1 evaluates the relationship between parallel exchange rates and economic performance in the post Bretton Woods period (1974-2001). The main findings are not only that parallel exchange rates are more likely to be adopted when economic performance is bad, but also that they hurt economic performance, indicating the existence of a negative feedback mechanism linking economic performance and parallel markets. It also finds that liability dollarization and high debt service are possible determinants of the likelihood to segment the foreign exchange market. Chapter 2 evaluates the effec-

tiveness of multiple exchange rates systems as a policy tool to stop capital outflows. Controlling for push and pull factors that drive capital flows, and using data from 46 developing countries for the 1980-2001 period, it cannot find empirical support for the claim that segmenting the foreign exchange market stops capital outflows. The evidence suggests that multiple exchange rates systems do not have any effect on capital outflows, at best. At worst, the evidence suggests that parallel exchange rate systems increase capital outflows rather than discouraging them. This last result can be rationalized with a policy signaling model for capital controls.

ESSAYS ON MULTIPLE EXCHANGE RATE SYSTEMS

by

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DEDICATION

With all my heart, to my wife Carmita and to my daughters, Arianna and Doménica for their love and unconditional support.

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Chapter 1

Parallel Exchange Rates and Economic Performance in Developing Countries: Is the Medicine Worse than the Disease?

1.1 Introduction

The response of Central Banks to swings in capital flows is an area within international finance that has received a lot of attention because of the impact such swings may have on macroeconomic performance. The imposition of capital controls is one way to deal with capital flow volatility. The discussion of their effectiveness has sparked an ongoing debate (Edison, Klein, Ricci and Sloek, 2002) in academia and in policy circles.

This chapter looks at a special case of capital controls: multiple exchange rate systems. Their imposition has been a policy instrument used to stop capital outflows and to avoid BOP crises. Recently Argentina (2002) and Venezuela (2003) have implemented multiple exchange rates in an effort to stop capital flight and to prevent financial crises, in situations where a unified devaluation is not a viable policy option, because high pass-through and liability dollarization imply that a unitary devaluation would lead to high inflation, deteriorating balance sheets and bankruptcies; and where defending the currency is also not an attractive option due to lack of reserves or concerns that rising interest rates will depress economic activity

and also hurt firms' profitability as debt service increases. These side effects make multiple exchange rate systems attractive, because they preserve the stabilization role of monetary policy and they also might stop capital flight without having an inflation spike.

Multiple exchange rates segment the foreign currency market so that different exchange rates apply to different types of transactions. When multiple exchange rates are in place, the government sets an official or preferential exchange rate for some -or all- current account transactions, and creates a parallel exchange rate at a higher value[1] for capital account transactions. So, if there is a run against the local currency or if there is a shock to the capital account, the parallel rate depreciates automatically, without affecting the domestic price of imports, and without forcing the Central Bank to lose reserves or increase interest rates.

Given the undesired side effects of the standard tools that Central Banks have available to defend their currencies, multiple exchange rates have been advocated as a good alternative, at least in the short run. For example, during the East Asian crisis, Krugman (1998) advocated for "something radical", suggesting the imposition of capital controls on outflows to help economic activity rebound in East Asian economies after IMF intervention seemed unsatisfactory[2]. Dornbusch (1986)

[1] Throughout this dissertation, the exchange rate is defined as units of local currency per unit of foreign currency.

[2] ..."Exporters were required to sell their foreign-currency earnings to the government at a fixed exchange rate; that currency would in turn be sold at the same rate for approved payments to foreigners, basically for imports and debt service. Whilst some countries tried to make other foreign exchange transactions illegal, other countries allowed a parallel market. Either way, once the system was in place, a country didn't have to worry that cutting interest rates would cause the currency to plunge.", Paul Krugman, Saving Asia: It's time to get radical, Fortune Magazine, (1998)

also recommended that developing countries should implement parallel exchange rates to protect domestic prices from speculative attacks to their currencies.

But Ghei, Kiguel and O'Connell (1997) question the effectiveness of parallel exchange rates. They conclude that the ability to insulate the economy from shocks fades over time. They also report that parallel exchange rates typically hide structural fiscal problems that ultimately result in higher parallel premiums, and in traumatic unifications.

Nevertheless, the impact of multiple exchange rates on macroeconomic performance has not received full attention in the literature. Most existing studies look at macroeconomic performance and capital controls without paying attention to their simultaneous determination[3]. Moreover, not all capital controls are created equal. Some policies target capital inflows while others restrict capital outflows.

This chapter looks at the implications of a particular type of control on outflows. It estimates both the effect of parallel exchange rates on economic performance and how economic performance influences the propensity to segment the foreign exchange market, using an unbalanced panel of 61 countries for the 1974-2001 period. It finds not only that multiple exchange rates hurt economic performance, but also that poor economic performance makes the adoption of parallel exchange rates more likely, suggesting the existence of a negative feedback mechanism between

[3]The empirical growth literature acknowledges this simultaneity problem, although it looks at the parallel premium mostly as a proxy for distortions caused by government intervention rather than as a policy tool to stop capital outflows. Moreover, the growth literature focuses on long run issues, rather than annual fluctuations, which are the focus of this chapter. Cardoso and Goldfajn (1998) look at the determinants of capital inflows in Brazil, controlling for the simultaneity of capital controls by including in their estimation a reaction function for the government which responds to capital inflows.

macroeconomic performance and foreign exchange market segmentation. It also finds that high debt service, liability dollarization and exchange rate pass-through make the adoption of parallel exchange rates more likely.

The chapter is structured as follows. Section 1.2 reviews some of the existing theoretical literature and empirical evidence on capital controls, multiple exchange rates and economic performance. Section 1.3 takes a look at the data. Section 1.4 describes the empirical methodology. Section 1.5 discusses the results and conducts some robustness checks. Finally, section 1.6 concludes.

1.2 Capital Controls, Multiple Exchange Rate Systems and Economic Performance: Literature Review

There is an active ongoing debate on the pros and cons of capital controls. As Edison et al (2002) point out, there are mixed empirical results on the effects of capital controls. From a theoretical standpoint, a leading argument against controls stresses that they prevent risk sharing and the efficiency gains that countries may obtain by allowing capital to flow freely. The opposing view stresses that countries with no capital controls face undesirable volatility when capital flows experience abrupt swings.

Cooper et al (1999) assert that the existing discussions of capital controls "do not lead to strong, definitive conclusions". They argue that liberalizing capital movements is a good idea if some conditions are met, such as low barriers to trade and healthy domestic financial markets. If these conditions do not hold, liberaliz-

ing capital movements would result in serious misallocations and macroeconomic vulnerability. Frenkel, Nickel, Schmidt and Stadtmann (2001) extend Dornbusch's overshooting model to investigate how capital controls affect exchange rates and output. They argue that capital controls increase domestic interest rates and hence they have a negative effect on economic performance because of the dampening effect on investment. Stockman and Hernández (1988) build a general equilibrium model to study the welfare effects of taxes on purchases of foreign currency and on foreign income bearing assets. They find that these taxes lower welfare and also reduce trade. Alesina, Grilli and Milesi-Ferretti (1993) study the political determinants of capital controls and the effect of capital controls on economic performance, using a sample of 20 OECD countries for the 1950-1989 period. They find that capital controls are introduced when the Central Bank lacks independence and they reject the hypothesis that capital controls reduce growth.

The literature not only presents mixed results on the desirability of capital controls in general, but also on the relative merits of controls on inflows versus controls on outflows. Cooper et al (1999) favor restrictions on capital outflows rather than restrictions on capital inflows. They also favor restrictions on short-term capital movements over restrictions on long term flows, like FDI. Edwards (1999) criticizes controls on capital outflows. He claims that they are ineffective, become permanent and foster corruption. He also points out that the impact of controls on capital inflows in Chile has been exaggerated. He argues that there was no significant effect on the Chilean real exchange rate and a very small effect on interest rates, while the capital controls program increased the cost of capital for small and medium size

firms. Cordella (1998) builds on Diamond and Dybvig (1983) to show that controls on capital inflows can reduce emerging markets vulnerability to shocks and hence can be successful in catalyzing capital flows. This happens because "the tax on inflows can prevent bank runs, and through this channel, can increase the expected returns on investing in emerging markets". This result suggests an improvement in economic performance. Tamirisa (2004) examines how the macroeconomic effects of capital controls in Malaysia vary depending on which type of financial transactions they cover. Using an error correction model, she reports that capital controls have negligible effects on the exchange rate. She also finds that controls on outflows reduce domestic interest rates, while controls on inflows do the opposite, a result that supports Edwards critique of the Chilean capital controls program and is also consistent with one of the purported advantages of multiple exchange rate systems. Reinhart and Smith (1997) study the macroeconomic effects and welfare consequences of temporary controls on capital inflows. They develop a monetary general equilibrium model, and find that controls on inflows are only effective if the tax rate is very high. They also conjecture that there might be negative welfare effects of capital controls if high domestic interest rates hurt real activity. Bhagwati (1998) says that the benefits of capital mobility are not persuasive. He points out that " Substantial gains have been asserted, not demonstrated [from capital mobility]". He suggests that it is a mistake to think that free capital mobility is as good as free trade, because capital flows are subject to "panics and manias" that push countries into trouble.

It may be argued that multiple exchange rates are not really capital controls,

in the sense that they are not explicit taxes on capital outflows and that they do not impose quantity restrictions that prevent capital from flowing freely. In a sense, capital is still free to move. But multiple exchange rates introduce a parallel market for financial transactions in foreign currency, with a floating exchange rate that automatically adjusts to pressures in the capital account. Since agents that want to buy foreign currency for imports face a lower exchange rate than agents trying to pull out their investments, in that sense, the parallel premium is like a tax agents have to pay to liquidate their investments from a country, with the feature that the tax rate adjusts with market forces. From this perspective, multiple exchange rates trigger a time varying endogenous tax on capital outflows (Marion 1997). When there is a speculative attack on the domestic currency, the parallel rate depreciates as much as needed to stop speculators from buying the foreign currency. As Dornbusch (1986) points out, assets markets are still integrated, but parallel exchange rates break the law of one price because devaluations occur only for financial transactions. More generally, as Ghei et al (1997) remark, "the spread between the parallel and official exchange rate acts as a shadow tax/subsidy scheme, penalizing individuals who surrender foreign exchange at the official rate and rewarding those who purchase it at the official rate." In this line, Easterly (1994) builds a model in which he shows that a higher premium acts as an implicit tax on exports, decreasing the steady state growth rate.

The empirical growth literature uses the parallel premium as a "proxy for government distortions of markets" (Barro and Sala-i-Martin (1998)) and finds a negative effect on economic growth. Fisher (1993) and Easterly (1994) report a

similar result. But, as indicated earlier, these papers look at the parallel black market premium as a proxy for government induced distortions on free markets. It is worth noting that in my approach, the parallel market premium is not "black" because there are not necessarily black markets. Instead, I look at episodes when the government has segmented the foreign exchange market, and legally has created several exchange rates for the same currency to prevent capital outflows. Furthermore, for the question that this chapter is exploring, the parallel premium itself is not meaningful, because there might be episodes of multiple exchange rates that have a very low premium if there is no inflation and monetary policy is perfectly consistent with the official rate[4]. My goal is to study episodes of foreign exchange market segmentation, regardless of the premium level.

Ghei, Kiguel and O'Connell (1997) also argue that export underinvoicing and import overinvoicing increase as controls remain in place for longer and as the parallel premium increases, creating a leak in the system and undermining the desired price-reserves insulation.

Kamin (1997) studies multiple exchange rates in Argentina from 1982 to 1989. He claims that the government chose controls without implementing a fiscal adjustment, deepening the crisis that ended in the hyperinflation of the late 80's. He also finds that the Argentine government had to continuously devalue the official (preferential) rate because the parallel premium was too high and exports began leaking to the parallel market increasingly. In an effort to stop this distortion in international trade, the government repeatedly tried to reduce the premium by devaluing the of-

[4]I would like to thank Carmen Reinhart for making this point.

ficial rate, but the devaluation of the official rate translated into higher inflation, with predictable results.

Kaminsky (1997) studies the Mexican experience with parallel rates from 1982 to 1987, and evaluates the ability of parallel rates to insulate domestic prices. She finds that the dual exchange rate system failed to insulate domestic prices. Specifically, using a VAR approach she finds that shocks to the parallel rate translated into higher inflation, hence rejecting the hypothesis of domestic price insulation.

Hausmann (1997) looks at the Venezuelan experience with capital controls in the $1983 - 1989$ period. This case is interesting because Venezuela not only adopted foreign exchange controls for the capital account, but also introduced import rationing. In his paper, Hausmann develops a model of dual exchange rate markets and import controls. He finds that the inconsistency between the exchange rate regime and fiscal policy was the main reason for the failure of the dual regime. This finding is remarkable because it highlights the relevance of sound fiscal policy, given that most of Venezuela's exports come from the public sector (Oil), so that trade leaks were not an issue in this case.

1.3 Some Facts and Figures

Before conducting a more rigorous analysis, and to understand better how multiple exchange rate systems are empirically related to economic performance, I look at the stylized facts within a sample of 2,581 annual observations between 1974-2001 for 113 developing countries. I included all countries with data on per

capita GDP growth and on multiple exchange rates. Table 1.1 splits the observations in groups with and without multiple rates, and shows some descriptive statistics[5]. Figure 1.1 plots the GDP per capita growth rate density for each group. The figure suggests that countries achieve higher economic growth on average without parallel rates than otherwise. In fact, table 1.1 tells us that countries with parallel rates have grown on average by -0.20%, whereas countries without multiple rates have grown by 1.94% on average. For illustrative purposes I perform in Table 2.2 a mean comparison test which rejects at 1% level the null hypothesis that mean GDP per capita growth is equal between these two groups, against the alternative that mean GDP growth is higher for countries without multiple exchange rates. It is worth noting that countries with multiple rates have also experienced higher volatility than countries with a unitary exchange rate. The standard deviation of per capita GDP growth is higher when countries decide to segment the foreign exchange market (8.388) than when they decide not to do so (7.295). Table 2.3 reports the result of a standard deviation comparison test, which rejects at 1% significance level the null hypothesis that both types of countries have the same volatility, against the alternative that countries without multiple exchange rates have lower volatility in per capita GDP growth rates. Figure 1.2 plots the cumulative distribution for the two groups. The figure suggests that the probability of observing GDP per capita growth rates less than or equal to any given value is always higher for countries with multiple rates[6]. To formalize these findings, I perform a non-

[5]If a country experienced at least 6 months of parallel rates is counted as "with multiple rates". I explain next this criteria in more detail.

[6]This is equivalent to say that the per capita GDP growth distribution without multiple rates first order stochastic dominates the one with multiple rates.

parametric hypotheses test to check whether or not these growth rates distributions are statistically different. The Wilcoxon rank-sum test rejects the null hypothesis that the growth rates distributions come from the same process at 1% significance level. Moreover, the estimated probability that GDP per capita growth without multiple rates is higher than GDP per capita growth with multiple rates is 0.60, supporting the preliminary finding that economic growth with multiple rates is lower than with unified rates.

Tables 1.4, 1.5 and 1.6 list the 113 countries included in the sample, and also how many periods they spend with and without multiple rates. Sixty-six countries have experienced periods with and without multiple exchange rates, eight countries have had multiple rates in the whole sample, and thirty-nine countries have never experienced multiple rates. The number of periods is not the same across countries because of data availability. It is also interesting to analyze how countries move from periods with multiple rates to periods without multiple rates and vice-versa. Table 1.7 shows the transition frequencies and the corresponding maximum likelihood estimates for the Markov transition probabilities [7]. In the full sample described above, 882 observations continued with multiple exchange rate systems in the following period, 96 observations abandoned multiple rates in the following period, 1,538 observations stayed away from multiple rates in the following period and 43 observations imposed multiple rates in the following period. These results confirm the fact that multiple exchange rates become persistent once they are implemented.

[7]The maximum likelihood estimates of the transition probabilities in a discrete state Markov process are the sample relative frequencies. See Bhat and Miller (2002, page 131) for a derivation of this result.

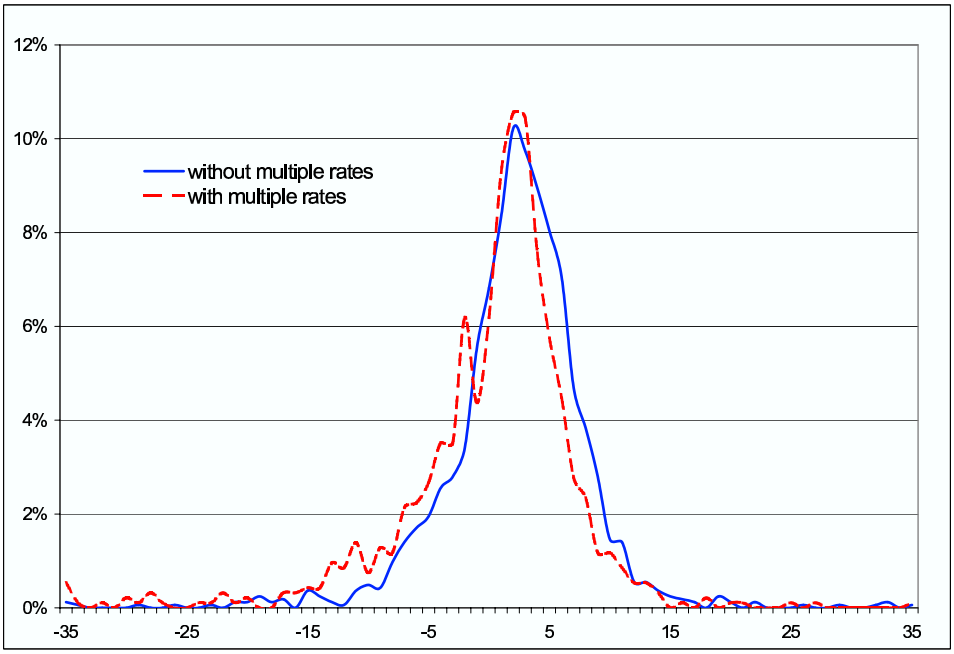

Figure 1.1: Density of Annual GDP Per Capita Growth Rates for Developing Countries between 1974-2001

This evidence, of course, does not prove that multiple exchange rates cause poor economic performance. Estimating the impact of multiple exchange rates is complicated by omitted variables and by reverse causality. For example, it might be the case that poor performance is due to currency crises and not to capital controls themselves, and because currency crises and multiple exchange rate episodes are positively correlated, one might mistakenly blame foreign exchange market segmentation for poor performance. Alternatively, poor economic performance per se might cause countries to adopt multiple exchange rate regimes. To tackle these problems, in the next section I conduct a comprehensive empirical analysis that controls for potential omitted variables and addresses simultaneity issues, among other things. In the appendix I describe the sources and definitions of the variables employed in next section.

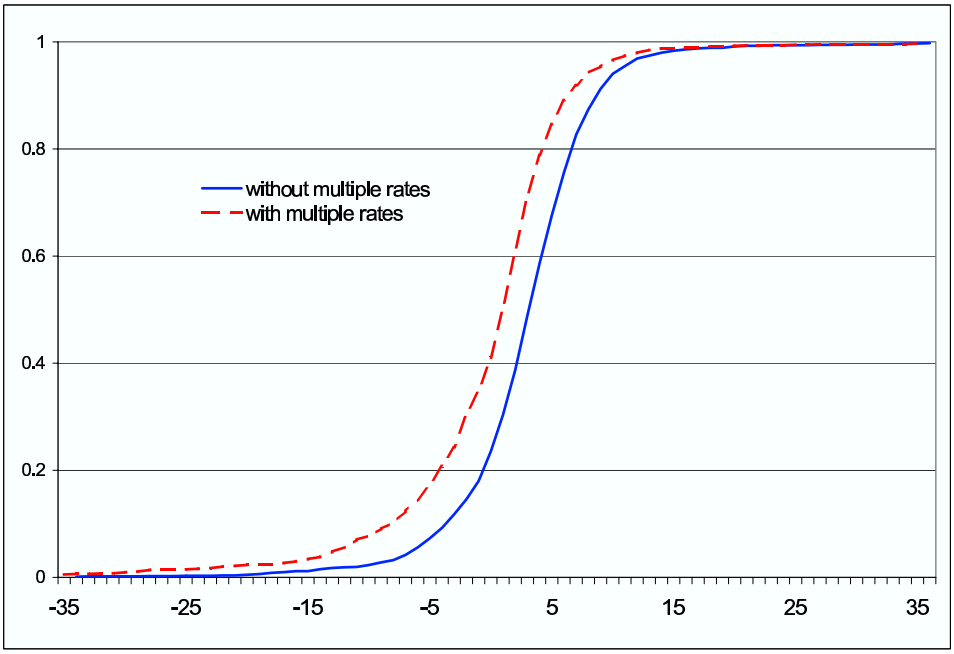

Figure 1.2: Cumulative Distribution of Annual GDP Per Capita Growth Rates for Developing Countries between 1974-2001

1.4 Empirical Methodology and Theoretical Underpinnings

To estimate the effects of multiple exchange rates on economic performance and vice-versa, I first estimate a system of equations by iterated 3SLS[8]. The benefit of using a system estimator is that if the equations are correctly specified, 3SLS is more efficient than 2SLS, at the expense that 3SLS has the drawback that if one or more of the equations is not correctly specified, all the estimates become inconsistent. For this reason I then re-estimate the system by 2SLS. This is an equation-by-equation estimator that lets me estimate each equation consistently even if the other one is misspecified. The endogenous variables for this system are measures of economic performance and foreign exchange controls. To mea-

[8]By iterated 3SLS I mean that besides the standard 3SLS procedure, I iterate on the variance-covariance matrix until the estimates converge, as in a feasible generalized least squares fashion.

sure economic performance I use annual per capita GDP growth; the econometric specification for the performance equation is borrowed from the empirical growth literature. Because there are many variables that potentially affect economic performance, I adopt a generally accepted specification, to which I add a binary variable *(multipleXR)* that is equal to 1 if a country has experienced at least 6 months of dual/multiple exchange rates system in a given year and zero otherwise[9]. I also add a discrete regressor *(crisisperyear)*, to control for the effects of currency crises on economic performance. To capture the effects of worldwide exogenous external shocks I include annual dummies.

The performance equation to estimate is:

$$gdp\_pc\_g_{i,t} = multipleXR_{i,t}\delta + X^{(1)}_{i,t}\beta_1 + X^{(2)}_{i,t-1}\beta_2 + \eta_t + u_{i,t} \tag{1.1}$$

where $gdp\_pc\_g_{i,t}$ is the growth rate of real per capita GDP in country i and period t, $X^{(1)}_{i,t}$ is a vector of explanatory variables for country i in period t, $X^{(2)}_{i,t-1}$ is a vector of additional explanatory variables for country i in period *t-1*, η_t is a set of year dummy variables that change across t but not across i and that capture aggregate shocks, and $u_{i,t}$ is an independent and identically distributed error term.

To build the multiple rates measure I look at "The Country Chronologies and Chartbook Background Material to a Modern History of Exchange Rate Arrangements: A Reinterpretation" by Reinhart and Rogoff (2004). In their appendix the second column indicates for each country the number of months in which there have

[9]The results in this chapter do not change if I take 3, 6 or 9 months of multiple rates as the threshold value to build the controls measure.

been parallel/multiple exchange rates. The crisis (*crisisperyear*) regressor adds the number of months within a year in which the local currency either experiences a monthly depreciation rate greater than or equal to 25% or when the difference from the previous month's depreciation rate is greater than or equal to 10%. The $X_{i,t}^{(1)}$ vector includes explanatory variables for the illiteracy rate *(ilit)*, civil liberties *(civil)*, political rights *(polright)* and terms of trade growth rate *(delta_tt)*. The $X_{i,t-1}^{(2)}$ vector includes explanatory variables for the investment rate *(gfkf_gdp)*, growth rate of the government consumption to GDP ratio *(g_gov_gdp)*, government's primary balance to GDP ratio *(budbal_gdp)* , M2 to GDP ratio *(m2_gdp)*, trade openness *(open)*, inflation rate *(inflation)*, total debt service to exports ratio *(tds_x)* and the net reserves to GDP ratio *(netres_gdp)*.

To identify the effect of multiple exchange rates on economic growth, I use as instruments the ratio of debt denominated in foreign currency to foreign long term debt *(currcomplt)* , the fraction of short term debt to external debt *(stdebt_xdebt)*, and the manufactures' fraction of total merchandise imports *(manufimports)*. To avoid simultaneity problems, all the excluded variables have been lagged one period. That is, the identifying assumption is that these 3 variables have no direct impact on next period growth, besides their indirect effect through the likelihood to implement a multiple exchange rate system in the next period.

The *currcomplt* variable captures the currency mismatch in a country's debt structure and proxies its degree of liability dollarization. The mismatch per se should not affect next period's growth rate directly, apart from its effect on the exchange rate regime. For example, if there is a negative shock that puts pressure

on the exchange rate and the currency mismatch is perceived to be critical, policy-makers would rather implement a partial devaluation through multiple rates rather than a unified devaluation. The partial devaluation then would leave interest payments unaffected, though principal payments would still increase (but they would have been affected anyway with a unified devaluation). So, given a negative shock, higher *currcomplt* makes a multiple exchange rate system more likely, which in turn may -or may not- affect growth. The *stdebt_xdebt* variable controls for the maturity imbalance that might be present in external debt, pushing a country into a liquidity crisis if a negative shock arrives. This measure of liquidity risk should not affect next period's output directly, apart from its effect on the exchange rate regime. As stated above, under a partial devaluation debt service remains unchanged, and this makes parallel rates more desirable when interest payments are concentrated in the near future. So the higher the liquidity risk, the more likely is a multiple exchange rate system, which in turn may -or may not- affect growth. Finally, *manufimports* is intended to capture the degree of potential pass-through that may exist in an economy. Manufactured imports are a good proxy for pass-through because a devaluation would affect their domestic price, triggering an inflationary process[10]. So countries where the share of manufactures in total imports is high, have a higher pass-through, and therefore when facing a potential devaluation would rather segment the foreign exchange market to keep inflation controlled.

So far I have described how to identify and estimate the effects of multiple

[10]The underlying assumption is that manufactured imports are part of households' consumption basket. See Bailliu and Bouakez (2004) for an updated survey.

exchange rate systems on economic performance. These effects can be estimated by 2SLS, which should yield consistent estimates of the causal link from multiple exchange rate systems to output growth. But another goal of this chapter is to find the determinants behind the decision to segment the foreign exchange market. So I still have to describe how to identify and estimate the effects of economic performance on the likelihood of segmenting the foreign exchange market.

To pin down the specification for the multiple exchange rate determination equation, I rely on economic theory and on case studies about this particular type of capital control. The instrumental variables described above are included variables in the multiple rate equation. I also include the terms of trade growth rate and the one period lags of the inflation rate, the total debt service to exports ratio, the net reserves to GDP ratio, the growth rate of the government consumption to GDP ratio and the government's primary balance to GDP ratio. As explained earlier, fear of inflation is one motivation policymakers have for choosing multiple exchange rates rather than devaluing the currency or increasing interest rates. For this reason I include lagged annual CPI inflation *(inflation)* as an explanatory variable, and I expect its sign to be positive. Most countries segment the foreign exchange market when facing BOP problems and as previously stated, countries choose to impose multiple exchange rates to insulate their reserves from shocks to the capital account. First generation models of BOP crises suggest that the stock of reserves and the fiscal variables are natural candidates for explanatory variables. The lower the reserves, the more likely that the Central Bank will segment the foreign exchange market because it is in a weaker position to defend a peg. Similarly, the worse the fiscal

performance, the more likely that multiple exchange rates would be observed.

Case studies suggest that parallel/multiple exchange rates are introduced when countries are having trouble paying their international debt (see Kamin (1997) on Argentina and Ghei et al (1997) on Mexico). Furthermore, debt intolerance (Reinhart, Rogoff and Savastano (2003)) plays a crucial role because as credit access conditions get harder, servicing external debt represents a bigger burden. Aizenmann and Guidotti (1994) study how large domestic public debt might be associated with the imposition of capital controls, when taxation is costly in welfare terms. They show that policymakers may want to introduce capital controls to reduce the cost of rolling over public debt. To control for this effect, I use the total debt service to exports ratio *(tds_x)*. I expect the sign of this coefficient to be positive.

To identify the effect of GDP growth on multiple exchange regime adoption, I use as excluded instruments the following regressors: crisis per year, the illiteracy rate, the civil liberties index, the political rights index, and one period lags of the investment to GDP ratio, M2 to GDP ratio, and trade openness *(open)*. I assume that all of these variables have an indirect impact on the likelihood to segment the foreign exchange market through their direct effect on economic growth. Then, using a linear probability model[11], I estimate the following equation:

[11] Although the linear probability model is not strictly appropriate if the dependent variable is dichotomous, it is often considered because it is simpler when the model contains endogenous variables. See Calvo, Izquierdo and Mejía (2004) for a similar application.

$$
\begin{aligned}
multipleXR_{i,t} &= \gamma_0 + \gamma_1 gdp\_pc\_g_{i,t} + \gamma_2 currcomplt_{i,t-1} + \gamma_3 manufimports_{i,t-1} \\
&+ \gamma_4 stdebt\_xdebt_{i,t-1} + \gamma_5 tds\_x_{i,t-1} + \gamma_6 delta\_tt_{i,t} \\
&+ \gamma_7 netres\_gdp_{i,t-1} + \gamma_8 inflation_{i,t-1} + \gamma_9 g\_gov\_gdp_{i,t-1} \\
&+ \gamma_{10} budbal\_gdp_{i,t-1} + \epsilon_{i,t} \qquad (1.2)
\end{aligned}
$$

Once all the regressors are taken into account, the sample reduces to 818 observations for 61 countries. Tables 1.8, 1.9 and 1.10 show the country list, descriptive statistics and pairwise correlations, respectively.

1.5 Estimation Results and Robustness Analysis

As a reference, Table 1.11 reports the estimation results using OLS. These results are not consistent because multiple exchange rates are endogenous, as Table 1.12 confirms. Table 1.13 shows the results for the estimation by 3SLS and 2SLS. The 3SLS estimation shows that the multiple rates coefficient in the performance equation is negative and significant at 1%. Crises per year, fiscal performance, and the investment and literacy rate have significant effects on growth with the expected sign. In the parallel rates adoption equation, the coefficient on economic growth is negative and significant at 5%. Liability dollarization, inflation pass-through, liquidity risk and debt service have significant effects at 1% with the expected signs. These results suggest that poor economic growth, liability dollarization (through the

balance sheet channel), fear of inflation, maturity imbalances and high debt service (relative to exports) have some power to explain the likelihood of observing multiple exchange rate systems, but at the same time, multiple exchange rate systems hurt economic performance. This negative feedback mechanism is what makes multiple exchange rate systems undesirable, because they do exactly the opposite of what they were designed to do.

A potential critique for these results could be that 3SLS requires more conditions for consistency than 2SLS, and therefore a robust and more conservative estimator should be used. The third and fourth columns in Table 1.13 show the results for the 2SLS estimation. As explained earlier the advantage is that misspecification of one equation affects that equation only, and does not contaminate the other one. The 2SLS results are similar to the baseline 3SLS estimation. Also notice that the null hypothesis that the estimated coefficients are jointly equal to zero is rejected for 3SLS and 2SLS.

Because there are more instruments than endogenous variables in each equation, it is possible to perform an overidentifiying restrictions test to check the validity of the instrument set. Table 1.14 displays the results of these tests for both equations, estimated by 2SLS. The validity of the instruments is not rejected for the performance equation, while it is disappointingly rejected for the controls equations. These results cast some doubt on the validity of the instruments utilized to identify the effect of economic performance on the likelihood of segmenting the foreign exchange market, but support the choice of instruments to identify the effect of multiple exchange rate systems on economic performance.

To verify the instruments' relevance, Tables 1.15 and 1.16 display the estimation results of the first stage regression for the growth and multiple exchange rate equations, respectively. Table 1.15 shows that the instrumental variables are not only individually and jointly significant but also have the expected sign. Table 1.16 shows that the instruments are jointly significant. In this case, the crisis, investment rate, human capital and trade openness instrumental variables are individually significant but the institutional and financial development instruments are not.

Is Unobserved Heterogeneity Important?

In order to check the robustness of the above results, I control for unobserved heterogeneity at the country level. As Mundlak (1978) argues, the key issue here is whether or not the unobserved country components are correlated or not with the right hand side regressors. Country specific effects may play a crucial role because it may be the case that countries that have lower long run growth are precisely the ones segmenting the foreign exchange market, introducing an important bias in the results. In the present case, I re-estimate the system of equations, using the baseline regressors plus country fixed effects in the growth regression and instrumenting for the endogenous variables as before. Table 1.17 shows estimation results allowing for unobserved heterogeneity across countries. In the growth equation, the controls measure is significant at 5%, whereas in the multiple rate equation, GDP per capita growth is significant at the 1% level. These results suggest that the negative link between economic growth and the likelihood of segmenting the foreign exchange

market is robust to the presence of unobserved country effects.

Are the results sensitive to the choice of the linear probability model?

A possible caveat of this results is that estimating equation (1.2) with a linear probability model is not a good choice because predicted probabilities are not bounded in the $[0, 1]$ interval[12]. As a response to this potential problem I use the two-stage estimation method described in Maddala (1983)[13] for simultaneous equations models in which one of the endogenous variables is continuous and the other endogenous variable is dichotomous. In the first stage, the endogenous variables are regressed on the exogenous variables, but the growth regression is estimated through OLS, and the controls regression through probit maximum likelihood. Then, using the fitted values from the first stage, equation (1.1) is estimated through OLS, while equation (1.2) is estimated through probit maximum likelihood. The third and fourth columns in table 1.17 present the results of this estimation. In the growth equation, the controls measure is significant at 5%, and in the multiple rate equation, GDP per capita growth is significant at the 10% level. These results suggest, again, that the negative link between economic growth and the likelihood of segmenting the foreign exchange market is not sensitive to the estimation technique used to model the likelihood of implementing parallel rates.

[12]See Johnston and Dinardo (1997, page 414) for an excellent discussion.
[13]See Maddala (1983, pages 244-245).

1.6 Conclusions

In this chapter I estimate the effect of multiple exchange rates on growth for developing countries, and also estimate the determinants of the decision to segment the foreign exchange market. I find not only that multiple exchange rates decrease economic growth but also that poor economic performance, liability dollarization, liquidity risk and a high debt service lead countries to segment the foreign exchange market. The former result is contrary to what Alesina et al (1993) find for OECD countries.

These findings suggest the existence of a contemporaneous feedback or reinforcing mechanism between multiple rates and economic performance. In other words, countries that try to keep economic activity by segmenting the foreign exchange market, may wind up depressing it instead.

These results are robust to potential model misspecification, country fixed effects, and to the choice of the probability model used to estimate the decision to segment the parallel market. However the validity of the instruments used to identify the effect of economic performance on the likelihood of adopting parallel rates is in doubt.

If multiple exchange rates hurt economic activity, and if they are imposed when things go bad, then why do we repeatedly observe governments segmenting foreign exchange markets when facing economic turmoil[14]? There is a potential answer in the Political Economy literature within the framework of signaling games. Bartolini

[14] Argentina (2002) and Venezuela (2003) are the most recent examples.

and Drazen (1997) show that in bad states of nature, some policymakers may want to signal their "tough" type and separate from others by liberalizing capital flows, while "weak" types cannot follow this policy and impose capital controls. But this answer raises the question on why the weak types impose controls, if economic growth will suffer anyway. My conjecture is that this is a "buying time" story. Weak types fall into the controls trap hoping to delay the crisis as much as possible, but as Reinhart and Rogoff (2004) show, most parallel rates episodes end up in traumatic and painful unifications.

1.7 Appendix

Appendix I: Sources and Definitions of Variables

All data is annual, and covers developing countries from 1974 to 2001.

budbal_gdp: Primary surplus as a fraction of GDP. Source: World Development Indicators 2003.

civil: civil liberties index, ranges from 1 to 7, where 1 is the best score and 7 is the worst. Source: Annual Freedom in the World Country Scores.

crisisperyear: The crisis per year regressor adds the number of months within a year in which the local currency either experiences a monthly depreciation rate greater than or equal to 25% or when the difference from previous month's depreciation rate is greater than or equal to 10%. Source: Prof. Carmen Reinhart.

currcomplt: The percentage of external long-term debt contracted in U.S. dollars for the low- and middle-income countries. Long-term external debt is defined as debt that has an original or extended maturity of more than one year and that is owed to nonresidents and repayable in foreign currency, goods, or services. Source: Global Development Finance 2001.

delta_tt: growth rate of term of trade. Source: Gosh, Gulde & Wolf dataset.

gdp_pc_g: Is the annual percentage growth rate of GDP per capita based on constant local currency. Source: World Development Indicators 2003.

g_gov_gdp: is the growth rate of government consumption as a fraction of GDP. Source: World Development Indicators 2003.

gfkf_gdp : Is physical investment as a fraction of GDP. Source: World Development Indicators 2003.

illit: is the illiteracy rate. Source:World Development Indicators 2003.

inflation: CPI inflation rate. Source: World Development Indicators 2003.

manufimports: Is the share of manufactures imports in total imports. Manufactures comprise the commodities in SITC sections 5 (chemicals), 6 (basic manufactures), 7 (machinery and transport equipment), and 8 (miscellaneous manufactured goods), excluding division 68 (nonferrous metals). Source: World Development Indicators 2003.

multipleXR : is a dichotomous variable that takes the value of 1 if in a given year a country has had multipe/dual exchange rates for at least 6 months, and zero otherwise. To build this dummy variable I look at appendixes 1 and 2 in

Reinhart and Rogoff (2002) Modern History of Exchange Rates. If for a given year there exist dual or multiple exchange rates markets for at least half of the time, controls is equal to one.

m2_gdp: is $M2$ as a fraction of GDP. Source: World Development Indicators 2003.

netres_gdp: Foreign net reserves as a fraction of GDP. World Development Indicators 2003.

open: is trade openness, where the latter is defined as export plus imports divided by GDP. Source: World Development Indicators 2003.

polright: political rights index, ranges from 1 to 7, where 1 is the best score and 7 is the worst. Source: Annual Freedom in the World Country Scores.

stdebt_xdebt: Short-term debt to total external debt. Source: Global Development Finance 2001.

tds_x: is total debt service, as a fraction of exports. Source :World Development Indicators 2003.

Appendix II: Tables

Table 1.1: GDP per capita growth with and without multiple exchange rate systems

	Obs	**Mean**	**Std. Dev.**	**Coef. Var.**	**Min**	**Max**
With multiple rates	938	-0.197	8.388	-42.579	-52.096	100.831
Without multiple rates	1643	1.940	7.295	3.760	-44.813	138.8972

Sample of 2,581 observations, 1974-2001

Table 1.2: Two Sample t-test of Equality of Means

Ho: means are equal	
Ha: mean with unitary exchange rates>mean with parallel rates	
Variable: GDP per capita growth	
$t_{1,736}$	6.520
P-value	0.000

Sample of 113 countries, 2,581 observations, 1974-2001
Unequal variances allowed.

Table 1.3: Variance Ratio Test

Ho: Std. Dev. are equal	
Ha: Std. Dev. with unitary exchange rates>Std. Dev. with parallel rates	
Variable: GDP per capita growth	
F_{1642}^{937}	1.3221
P-value	0.000

Sample of 113 countries, 2,581 observations, 1974-2001

Table 1.4: Developing countries with and without periods of multiple exchange rates (1974-2001)

	Number of periods		
Countries	With unified exchange rate	With multiple exchange rate	Total
Albania	9	2	11
Algeria	8	20	28
Argentina	16	12	28
Armenia	6	4	10
Azerbaijan	6	3	9
Belarus	4	7	11
Bolivia	1	27	28
Botswana	22	6	28
Brazil	3	25	28
Burundi	13	15	28
Chile	7	21	28
China	8	20	28
Colombia	8	20	28
Congo, Dem. Rep.	9	19	28
Costa Rica	18	10	28
Croatia	7	2	9
Dominican Republic	2	26	28
Ecuador	19	9	28
El Salvador	12	16	28
Gambia, The	23	5	28
Georgia	5	6	11
Ghana	8	20	28
Guatemala	11	17	28
Guinea-Bissau	24	4	28
Guyana	14	14	28
Haiti	21	7	28

Table 1.4 (Continued): Developing countries with and without periods of multiple exchange rates (1974-2001)

	Number of periods		
Countries	With unified exchange rate	With multiple exchange rate	Total
Kazakhstan	5	6	11
Kenya	11	17	28
Lebanon	10	3	13
Lesotho	16	12	28
Liberia	14	11	25
Malawi	19	9	28
Mauritania	6	22	28
Mauritius	20	1	21
Mexico	18	10	28
Moldova	7	4	11
Mongolia	9	2	11
Nepal	19	9	28
Nicaragua	12	13	25
Nigeria	9	19	28
Pakistan	3	25	28
Paraguay	13	15	28
Peru	11	17	28
Philippines	17	11	28
Poland	7	4	11
Romania	10	10	20
South Africa	10	18	28
Sri Lanka	24	4	28
Suriname	2	26	28
Swaziland	15	13	28
Tajikistan	6	4	10
Tanzania	7	6	13

Table 1.5: Developing countries without multiple exchange rate periods (1974-2001)

	Number of periods		
Countries	With unified exchange rate	With multiple exchange rate	Total
Antigua and Barbuda	24	0	24
Benin	28	0	28
Bosnia & Herzegovina	7	0	7
Bulgaria	12	0	12
Burkina Faso	28	0	28
Cameroon	28	0	28
Central African Rep.	28	0	28
Chad	28	0	28
Cote d'Ivoire	28	0	28
Czech Republic	11	0	11
Dominica	24	0	24
Equatorial Guinea	16	0	16
Estonia	11	0	11
Gabon	28	0	28
Grenada	24	0	24
Guinea	15	0	15
India	28	0	28
Korea, Rep.	28	0	28
Kyrgyz Republic	11	0	11
Latvia	11	0	11
Lithuania	11	0	11
Macedonia, FYR	9	0	9
Madagascar	28	0	28
Malaysia	28	0	28
Mali	28	0	28
Malta	28	0	28
Marshall Islands	19	0	19
Micronesia, Fed. Sts	14	0	14
Morocco	28	0	28
Niger	28	0	28
Panama	28	0	28
Senegal	28	0	28
Slovak Republic	9	0	9
St. Kitts and Nevis	24	0	24
St. Lucia	21	0	21
St. Vincent & Grndns	28	0	28
Thailand	28	0	28
Togo	28	0	28
Tunisia	28	0	28

Table 1.6: Developing countries without unified exchange rate periods (1974-2001)

	Number of periods		
Countries	With unified exchange rate	With multiple exchange rate	Total
Egypt, Arab Rep.	0	28	28
Iran, Islamic Rep.	0	27	27
Lao PDR	0	17	17
Libya	0	14	14
Myanmar	0	28	28
Russian Federation	0	10	10
Syrian Arab Republic	0	28	28
Turkmenistan	0	9	9

Table 1.7: Sample Frequencies and transition probabilities MLE

		Period t+1		
		Multiple Exchange Rate	Unified Exchange Rate	Total
Period t	Multiple Exchange Rate	882	96	978
	Unified Exchange Rate	43	1,538	1,581
				2,559

		Period t+1	
		Multiple Exchange Rate	Unified Exchange Rate
Period t	Multiple Exchange Rate	0.902	0.098
	Unified Exchange Rate	0.027	0.973

Table 1.8: Periods with Multiple Rates: 61 Countries Effective Sample

	Number of periods				Number of periods		
Countries	With unified exchange rate	With multiple exchange rate	Total	Countries	With unified exchange rate	With multiple exchange rate	Total
Bolivia	1	12	13	Mexico	10	10	20
Brazil	1	11	12	Nepal	17	6	23
Chile	5	19	24	Nicaragua	7	6	13
China	6	3	9	Nigeria	2	4	6
Colombia	6	20	26	Pakistan	1	25	26
Costa Rica	12	10	22	Paraguay	11	13	24
Dominican Rep.	2	11	13	Peru	8	12	20
Ecuador	12	7	19	Philippines	15	7	22
Hungary	7	9	16	Sri Lanka	18	2	20
Jamaica	12	5	17	Turkey	16	8	24
Jordan	20	1	21	Uganda	1	1	2
Kenya	7	16	23	Uruguay	16	5	21
Malawi	8	2	10	Venezuela, RB	9	17	26
Mauritius	18	1	19	Zimbabwe	6	9	15
Burundi	0	6	6	Guatemala	0	7	7
Egypt	0	23	23	Iran	0	3	3
Gambia, The	0	2	2	Russian Fed.	0	1	1
Ghana	0	11	11	Syria	0	7	7
Albania	3	0	3	Lithuania	5	0	5
Algeria	5	0	5	Madagascar	10	0	10
Argentina	10	0	10	Malaysia	24	0	24
Belarus	1	0	1	Moldova	3	0	3
Bulgaria	3	0	3	Morocco	23	0	23
El Salvador	1	0	1	Panama	18	0	18
Estonia	4	0	4	Poland	5	0	5
Honduras	3	0	3	Romania	8	0	8
India	24	0	24	Senegal	11	0	11
Indonesia	18	0	18	South Africa	5	0	5
Kazakhstan	2	0	2	Thailand	24	0	24
Korea, Rep.	22	0	22	Tunisia	15	0	15
Latvia	5	0	5				

Table 1.9: Effective Sample Descriptive Statistics

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
gdp_pc_g	818	1.801	4.617	-28.733	16.545
illit	818	25.708	21.407	0.204	81.962
civil	818	3.869	1.379	1.000	7.000
polright	818	3.572	1.756	1.000	7.000
multipleXR	818	0.381	0.486	0.000	1.000
crisisperyear	818	0.089	0.333	0.000	3.000
delta_tt	818	-0.004	0.126	-0.780	0.749
gfkf_gdp(-1)	818	21.448	6.475	3.531	43.586
g_gov_gdp(-1)	818	-0.001	0.116	-0.546	1.513
budbal_gdp(-1)	818	-3.727	4.325	-31.297	5.413
m2_gdp(-1)	818	35.254	19.576	6.801	132.478
inflation(-1)	818	27.499	61.761	-7.634	951.649
netres_gdp(-1)	818	0.084	0.065	0.003	0.407
currcomplt(-1)	818	49.529	18.485	0.400	93.000
fuel_merch(-1)	818	14.569	9.966	0.276	58.614
stdebt_xdebt(-1)	818	16.148	11.411	0.000	72.979
tds_x(-1)	818	22.627	13.228	0.284	81.755
open(-1)	818	58.719	30.059	6.320	192.114
manufimports(-1)	818	65.783	11.578	28.853	90.592

Table 1.10: Pairwise Correlations

	gdp_pc_g	illit	civil	polright	multipleXR	crisisperyear	delta_tt	gfkf_gdp(-1)	g_gov_gdp(-1)
gdp_pc_g	1.0000								
illit	-0.0426	1.0000							
civil	0.0237	0.3771	1.0000						
polright	0.0229	0.3346	0.8350	1.0000					
multipleXR	-0.1528	0.1602	0.0764	0.0853	1.0000				
crisisperyear	-0.2048	-0.0672	-0.0199	0.0110	0.1374	1.0000			
delta_tt	0.0713	-0.0220	-0.0412	-0.0186	-0.0287	-0.1080	1.0000		
gfkf_gdp(-1)	0.1927	-0.2330	0.0393	0.0182	-0.2683	-0.0281	0.0315	1.0000	
g_gov_gdp(-1)	-0.0393	0.0163	-0.0230	-0.0244	-0.0169	-0.0273	0.0204	0.0227	1.0000
budbal_gdp(-1)	0.0953	-0.3897	-0.1796	-0.0996	-0.1113	-0.0720	0.0112	0.0707	-0.0563
m2_gdp(-1)	0.1310	0.0226	0.1148	0.1218	-0.1703	-0.0874	-0.0161	0.4486	-0.0396
inflation(-1)	-0.0746	-0.1309	-0.0406	-0.0289	0.1129	0.1790	-0.0108	-0.0905	-0.0670
netres_gdp(-1)	0.1733	-0.2550	-0.0654	-0.0679	-0.1341	-0.1209	-0.0182	0.3685	-0.0003
currcomplt(-1)	-0.1188	-0.1064	-0.1621	-0.1383	0.1917	0.0921	-0.0052	-0.1022	-0.0052
manufimports(-1)	0.0125	-0.3095	-0.1381	-0.1148	-0.0122	-0.0188	0.0001	0.1450	0.0303
stdebt_xdebt(-1)	-0.0122	-0.3407	-0.1807	-0.1394	0.0014	0.0693	0.0179	0.2851	0.0545
tds_x(-1)	-0.1698	-0.1175	0.0247	0.0342	0.2133	0.1296	0.0050	-0.1938	0.0032
open(-1)	0.0825	-0.2473	-0.1278	-0.1031	-0.3528	-0.1370	0.0120	0.4415	-0.0582

	budbal_gdp(-1)	m2_gdp(-1)	inflation(-1)	netres_gdp(-1)	currcomplt(-1)	manufimports(-1)	stdebtxt(-1)	tds_x(-1)	open(-1)
gdp_pc_g									
illit									
civil									
polright									
multipleXR									
crisisperyear									
delta_tt(-1)									
gfkf_gdp(-1)									
g_gov_gdp(-1)									
budbal_gdp(-1)	1.0000								
m2_gdp(-1)	-0.0458	1.0000							
inflation(-1)	-0.0258	-0.2164	1.0000						
netres_gdp(-1)	0.2944	0.4112	-0.1253	1.0000					
currcomplt(-1)	-0.0886	-0.0839	0.1079	-0.1674	1.0000				
manufimports(-1)	0.3431	0.0208	-0.0967	0.3276	-0.0042	1.0000			
stdebt_xdebt(-1)	0.2430	0.0076	0.0161	0.0295	0.0995	0.2092	1.0000		
tds_x(-1)	-0.0077	-0.2295	0.1298	-0.2438	0.1666	0.0037	-0.1524	1.0000	
open(-1)	0.0556	0.4782	-0.1988	0.5082	-0.2233	0.0775	0.0400	-0.3271	1.0000

Table 1.11: OLS Estimation Results

Variable	**Coefficient**	**(t-stat.)**
Equation 1: Economic Growth		
multipleXR	-1.014***	(2.76)
crisisperyear	-2.302***	(4.79)
gfkf_gdp(-1)	0.106***	(3.54)
illit	-0.010	(1.12)
g_gov_gdp(-1)	-2.412*	(1.80)
budbal_gdp(-1)	0.009	(0.22)
civil	0.013	(0.06)
polright	0.067	(0.41)
delta_tt	1.388	(1.11)
m2_gdp(-1)	0.007	(0.69)
open(-1)	-0.024***	(3.42)
inflation(-1)	-0.003	(1.01)
tds_x(-1)	-0.041***	(3.07)
netres_gdp(-1)	9.123***	(2.90)
intercept	1.160	(0.50)
P-value	0.000	
Equation 2: Multiple Exchange Rate		
gdp_pc_g	-0.009***	(2.57)
currcomplt(-1)	0.003***	(3.71)
manufimports(-1)	0.001	(0.90)
stdebt_xdebt(-1)	0.001	(0.86)
tds_x(-1)	0.006***	(4.54)
delta_tt	-0.083	(0.64)
netres_gdp(-1)	-0.238	(0.83)
inflation(-1)	0.001*	(1.91)
g_gov_gdp(-1)	-0.100	(0.70)
budbal_gdp(-1)	-0.011***	(2.64)
intercept	-0.058	(0.49)
P-value	0.000	
Observations	818	

Significance levels : * : 10% ** : 5% *** : 1%

Absolute value of t-statistics are reported in parentheses.

Robust standard errors computed.

Variables in italic are the excluded instruments.

Table 1.12: Tests of Endogeneity for Multiple Exchange Rates

Ho: Regressor is Exogenous	
Equation 1: Economic Growth	
Wu-Hausman F test	
F^1_{777}	6.789
P-value	0.009
Durbin-Wu-Hausman χ^2 test	
χ^2_1	7.085
P-value	0.008

Table 1.13: 3SLS and 2SLS Estimation Results

	Iterated 3SLS		2SLS	
Variable	**Coefficient**	**(t-stat.)**	**Coefficient**	**(t-stat.)**
Equation 1: Economic Growth				
multipleXR	-9.273***	(3.48)	-6.405***	(2.56)
crisisperyear	-1.940***	(3.59)	-1.644**	(1.96)
gfkf_gdp(-1)	0.120**	(2.39)	0.025	(0.47)
illit	-0.017**	(2.12)	-0.009	(0.76)
g_gov_gdp(-1)	-2.905	(1.60)	-2.871*	(1.79)
budbal_gdp(-1)	-0.094*	(1.75)	-0.007	(0.14)
civil	-0.053	(0.32)	0.007	(0.03)
polright	0.043	(0.35)	0.083	(0.45)
delta_tt	0.644	(0.38)	1.039	(0.65)
m2_gdp(-1)	0.005	(0.54)	0.016	(1.07)
open(-1)	-0.015	(1.23)	-0.048***	(3.23)
inflation(-1)	0.002	(0.68)	-0.001	(0.19)
tds_x(-1)	0.020	(0.97)	-0.019	(1.00)
netres_gdp(-1)	1.436	(0.24)	18.370***	(3.20)
intercept	1.963	(0.56)	7.624**	(2.22)
P-value	0.000		0.000	
Equation 2: Multiple Exchange Rate				
gdp_pc_g	-0.023**	(2.12)	-0.022**	(2.01)
currcomplt(-1)	0.002***	(2.89)	0.003***	(3.46)
manufimports(-1)	0.002*	(1.68)	0.001	(0.75)
stdebt_xdebt(-1)	0.002*	(1.77)	0.001	(0.79)
tds_x(-1)	0.006***	(4.12)	0.005***	(3.99)
delta_tt	-0.048	(0.36)	-0.049	(0.32)
netres_gdp(-1)	-0.192	(0.66)	-0.132	(0.46)
inflation(-1)	0.001*	(1.88)	0.000**	(2.33)
g_gov_gdp(-1)	-0.130	(0.91)	-0.117	(0.85)
budbal_gdp(-1)	-0.012***	(2.74)	-0.010**	(2.52)
intercept	-0.010	(0.08)	0.000	(0.00)
P-value	0.000		0.000	
Observations	818		818	

Significance levels : * : 10% ** : 5% *** : 1%

Absolute value of t-statistics are reported in parentheses.

Robust standard errors computed.

Variables in italic are the excluded instruments.

Table 1.14: Tests of Overidentifying Restrictions

Ho: The excluded instruments are valid	
Equation 1: Economic Growth	
Hansen J Statistic	
χ^2_2	0.014
P-value	0.993
Equation 2: Multiple Exchange Rate	
Hansen J Statistic	
χ^2_{33}	168.134
P-value	0.000

Table 1.15: First Stage Regression for Growth Equation
Dependent Variable: *multipleXR*

Variable	**Coefficient**	**(t-stat.)**
crisisperyear	0.113**	(2.46)
gfkf_gdp(-1)	-0.017***	(5.91)
illit	0.002*	(1.76)
g_gov_gdp(-1)	-0.109	(0.84)
budbal_gdp(-1)	-0.006	(1.52)
civil	0.008	(0.37)
polright	0.003	(0.17)
delta_tt	-0.060	(0.50)
m2_gdp(-1)	0.002	(1.48)
open(-1)	-0.004***	(5.24)
inflation(-1)	0.000*	(1.68)
tds_x(-1)	0.004***	(3.37)
netres_gdp(-1)	1.648***	(5.27)
currcomplt(-1)	0.002**	(2.15)
manufimports(-1)	0.005***	(3.11)
stdebt_xdebt(-1)	0.004**	(2.24)
intercept	0.614**	(2.42)
F-test for joint significance of instruments (P-value)	0.000	
Observations	818	

Significance levels : * : 10% ** : 5% *** : 1%
Absolute value of t-statistics are reported in parentheses.
Robust standard errors have been computed.
Instrumental variables in italic.

Table 1.16: First Stage Regression for Multiple Exchange Rate Equation
Dependent Variable: *gdp_pc_g*

Variable	**Coefficient**	**(t-stat.)**
currcomplt(-1)	-0.012	(1.31)
manufimports(-1)	-0.029*	(1.82)
stdebt_xdebt(-1)	-0.026	(1.52)
tds_x(-1)	-0.048***	(3.51)
delta_tt	1.431	(1.14)
netres_gdp(-1)	7.665**	(2.36)
inflation(-1)	-0.004	(1.30)
g_gov_gdp(-1)	-2.163	(1.61)
budbal_gdp(-1)	0.036	(0.80)
crisisperyear	-2.366***	(4.94)
gfkf_gdp(-1)	0.135***	(4.48)
illit	-0.020**	(2.00)
civil	-0.043	(0.20)
polright	0.067	(0.41)
m2_gdp(-1)	0.007	(0.64)
open(-1)	-0.025***	(3.46)
intercept	3.625	(1.38)
F-test for joint significance of instruments (P-value)	0.000	
Observations	818	

Significance levels : * : 10% ** : 5% *** : 1%

Absolute value of t-statistics are reported in parentheses.

Robust standard errors have been computed.

Instrumental variables in italic.

Table 1.17: Robustness Analysis

	Iterated 3SLS with Fixed Effects		**2SLS with Continuous and Discrete Endogenous Variables**[1]	
Variable	**Coefficient**	**(t-stat)**	**Coefficient**	**(t-stat)**
Equation 1: Economic Growth				
multipleXR	-6.757**	(2.28)	-1.971**	(2.39)
crisisperyear	-1.357***	(2.75)	-1.609**	(2.32)
gfkf_gdp(-1)	-0.053	(1.40)	0.002	(0.03)
illit	-0.139	(1.31)	-0.012	(1.07)
g_gov_gdp(-1)	-2.293*	(1.76)	-3.229*	(1.89)
budbal_gdp(-1)	-0.061	(1.26)	-0.040	(0.68)
civil	-0.198	(0.82)	-0.027	(0.10)
polright	-0.122	(0.62)	0.126	(0.61)
delta_tt	1.191	(1.00)	1.103	(0.71)
m2_gdp(-1)	-0.059**	(2.18)	0.026*	(1.67)
open(-1)	0.009	(0.42)	-0.062***	(3.13)
inflation(-1)	-0.002	(0.62)	-0.002	(0.50)
tds_x(-1)	0.007	(0.41)	-0.012	(0.57)
netres_gdp(-1)	22.906***	(4.38)	20.447***	(3.05)
intercept			3.296	(1.50)
P-value	0.000		0.000	
Equation 2: Multiple Exchange Rate				
gdp_pc_g	-0.021***	(3.16)	-0.024*	(1.68)
currcomplt(-1)	0.003***	(3.12)	0.003***	(3.06)
manufimports(-1)	0.001	(0.78)	0.001	(0.68)
stdebt_xdebt(-1)	0.001	(0.85)	0.001	(0.49)
tds_x(-1)	0.006***	(4.15)	0.006***	(3.20)
delta_tt	-0.052	(0.40)	-0.045	(0.29)
netres_gdp(-1)	-0.149	(0.51)	-0.160	(0.41)
inflation(-1)	0.000*	(1.81)	0.001*	(1.69)
g_gov_gdp(-1)	-0.117	(0.83)	-0.121	(0.69)
budbal_gdp(-1)	-0.010**	(2.46)	-0.011**	(1.99)
intercept	0.011	(0.09)		
P-value	0.000		0.000	
Observations	818		818	

Significance levels : * : 10% ** : 5% *** : 1%

[1] marginal effects reported for multiple rate equation

t-statistics are reported in parentheses. Robust standard errors computed.

Variables in italic are the excluded instruments.

Chapter 2

Do Multiple Exchange Rates Stop Capital Outflows? Evidence from Developing Countries

2.1 Introduction

Capital outflows can be a serious problem and may create havoc and turmoil in economies that have enjoyed the benefits of being capital importers. When facing a situation like this, policymakers are tempted to impose capital controls to avoid or ameliorate a crisis and to prevent capital from flying out. In this chapter I look at a special case of capital controls on outflows: Multiple exchange rate systems.

Multiple exchange rate systems segment the foreign currency market so that different exchange rates apply to different types of transactions. When multiple exchange rates are in place, the government sets an official or preferential exchange rate for some -or all- current account transactions, and creates a parallel flexible exchange rate, at a higher value for capital account transactions. So, if there is a run against the local currency or a shock to the capital account, the parallel rate depreciates automatically without affecting the domestic price of imports, and without forcing the Central Bank to lose reserves or increase interest rates. The main objective is to stop capital flight[1].

[1] "...Even in a crisis, it may be preferable to adopt a dual-exchange-rate-system, which maintains a relatively fixed exchange rate for current account transactions and a floating rate for speculative financial transactions. Such a system has the advantage of allowing the exchange rate to respond to

The effectiveness of capital controls has been largely questioned in academia and policy circles, because it is not clear that they achieve the goals they are intended for. Theoretical models predict a lot of benefits from free capital mobility, but capital flow reversal episodes raise the possibility that the costs of free capital mobility are too high compared to the potential benefits (Kose and Prasad (2004)).

This chapter contributes to the debate by measuring the impact of multiple rates on capital flows in developing countries for the 1980-2001 period. Using instrumental variables and dynamic panel data techniques to handle endogeneity problems and unobserved country effects, it finds that multiple exchange rates systems have at best no effect on net capital outflows. At worst, the chapter finds that parallel exchange rate systems increase net capital outflows rather than stop them. This result suggests that when policymakers segment the foreign exchange market in the heels of a financial crisis, they may exacerbate the crisis instead of alleviating it. This can be the optimal response of a government with few sources of fiscal revenue available besides foreign capital taxation.

The chapter is structured as follows. Section 2.2 reviews the recent literature on the effects of capital controls on capital flows. Section 2.3 proposes a theoretical explanation due to Bartolini and Drazen (1997) and Drazen (1997) to rationalize the possibility that controlling capital outflows may reduce net capital inflows. Section 2.4 explores the data and shows some preliminary results and stylized facts that motivate this chapter. It also takes an event study approach to examine net capital

fluctuations in speculative supplies and demands for foreign exchange. The exchange rate response, being an equilibrating price signal, tends to reduce speculation.", John T. Cuddington, in Capital Flight, Estimates, Issues and Explanations, Princeton Studies in International Finance, (1986).

flows behavior before and after default, currency and banking crises. Section 2.5 develops and explains the econometric methodology employed to quantify the effect of multiple exchange rates systems on net capital flows, and presents the estimation results. Finally section 2.6 discusses some concluding remarks and future extensions.

2.2 Multiple Exchange Rates and Capital Flows: What Do We Know?

The benefit of free capital mobility is one of the most controversial and unsettled issues within the international finance literature. Theory mentions many benefits from having an open capital account. For example, Prasad, Rogoff, Wei and Kose (2004) distinguish between direct and indirect benefits from financial integration. By direct benefits they list "the augmentation of domestic savings, reduction in the cost of capital through better global allocation of risk, transfer of technological and managerial know-how and stimulation of domestic financial sector development". By indirect benefits they consider the "promotion of specialization, commitment to better economic policies and signaling". However, the authors also remark that is has not been possible so far to establish an empirical robust relationship between financial integration and economic performance.

But all that glitters is not gold. Second generation models of currency crisis predict that it is possible that countries may suffer capital outflows or currency crises, even if they have strong fundamentals, raising the issue of potential threats from not having some kind of capital controls. Because of capital market imperfections (like asymmetric information), foreign investors may pull their investments out

from a country, triggering a crisis, even if macroeconomic fundamentals are sound. The literature also shows that herd behavior can make things even worse (Gale (1996)). For example, the contagion literature shows that the financial channel may become important in spreading shocks from one country to another (Calvo (1999), Kaminsky and Reinhart (2000) and (2001)). In that sense, capital controls may place "sand in the wheels of market discipline" (Tobin (1978)), by stopping capital outflows and reducing the likelihood of a crisis and hence macroeconomic volatility. Furthermore, Kaminsky, Reinhart and Végh (2004) show that capital flows are procyclical, implying that capital outflows amplify the potential damage of a negative shock, a phenomenon that the authors label as "when it rains, it pours".

The nineties witnessed a dramatic surge in capital flows to emerging market countries (Fernández-Arias and Montiel (1996)) that posed significant challenges to policymakers. Calvo, Leiderman and Reinhart (1994) argue that capital inflows were "associated with inflationary pressures, real exchange rate appreciation, a deterioration in the current account and a boom in bank lending". Policymakers were concerned about the potential devastating effects of capital flows reversals, especially if capital flows were short term (hot money). Reinhart and Smith (1997) document how some countries resorted to controls on capital inflows as a way to tilt the composition of capital flows from short term to long term flows, in an attempt to decrease the likelihood of capital flows reversals.

The eruption of the East Asian crisis also contributed to the debate of whether or not there should be capital controls. At that time, Krugman (1998) said that it was "time to get radical" and impose capital controls when the IMF rescue packages'

results were disappointing in his view. Bhagwati (1998) said that the benefits from free capital mobility "have not been yet demonstrated". Stiglitz (2003) blamed capital account liberalization as "the single most important factor leading to the crisis". To cope with the Asian crisis, Malaysia imposed controls on capital outflows and recovered quickly from it (Kaplan and Rodrick (2001)). To prevent contagion, Chile imposed controls on capital inflows. But capital controls in general, and foreign exchange controls specifically, are not things of the past. The recent financial crises in Argentina (2002), Uruguay (2002) and Venezuela (2003) have brought to the forefront the question of the optimality of capital controls as a policy tool to stop capital outflows. For example Argentina (2002) and Venezuela (2003) have recently imposed restrictions on foreign exchange.

The empirical literature presents mixed results on the effectiveness of capital controls (Edison, Klein, Ricci and Sloek (2002)) although most "empirical studies lack a common methodology" (Magud and Reinhart (2005))[2]. Prasad, Rumbaugh and Wang (2005) argue that the Latin American experience in the 1980s "demonstrates that capital controls have generally not been very effective in restricting capital outflows". Tamirisa (2004) reports negligible effects of capital controls on exchange rates in Malaysia. Kaplan and Rodrick (2001) argue that the Malaysian capital controls program was successful if it is compared with the Thai and Korean performance after going to the IMF for assistance. Edison and Reinhart (1999) find that the Malaysian capital controls program improved interest rate and exchange

[2]Magud and Reinhart (2005) identify three additional problems that are present in the capital controls literature: The absence of a "unified framework to analyze the macroeconomic consequences of controls, the significant heterogeneity across countries and time in the controls measures implemented and the multiple definitions of what constitutes a "success"".

rate stability. Forbes (2004) surveys the empirical literature that evaluates the effects of capital controls using micro data. She discusses empirical research done for Malaysia (Johnson and Mitton (2002)) and Chile (Forbes (2003)), among others. She argues that during the Asian crisis the Malaysian capital controls program "reduced market discipline and provided a shelter for government cronyism"; she also argues that the Chilean capital controls program "made it relatively more difficult and expensive for smaller companies to raise financing". Because of the costs associated with capital controls, she concludes that capital controls are not "sand" but "mud in the wheels of market discipline". Edwards (1999) claims that capital controls are ineffective, become permanent and foster corruption. He also claims that the Chilean capital controls program increased the cost of capital for small and medium size firms. Avellán (2005) looks at the persistence of capital controls and estimates the transition probabilities between periods with and without capital controls. He finds that capital controls are very persistent. Magud and Reinhart (2005) also observe that temporary capital controls sometimes become permanent. They raise the point that even temporary capital controls may have a permanent impact on the economy because they signal governments' preferences toward capital mobility in times of distress. The link between the persistence and the effectiveness of capital controls has also received some attention. Rogoff (2002) asserts that "capital controls often breed corruption" and that their effectiveness fades over time. Prasad, Rumbaugh and Wang (2005) agree with this last point.

The international finance literature calls "impossible trinity" the trilemma policymakers face when they cannot simultaneously set a fixed exchange rate regime,

an open capital account and an exogenous monetary policy. (When countries implement capital controls with an inflexible exchange rate system, they are trying to get room to use monetary policy as a tool to affect economic activity). Multiple exchange rates systems constitute an alternative, where countries try to have all the three policy options available. They still have some sort of fixed exchange rate regime for current account transactions, they use monetary policy actively, and the capital account is still open in the sense that quantitative restrictions on capital outflows are absent. In fact, capital can still leave, but it will be punished in the parallel market with a higher exchange rate, which will likely float and adjust to curb speculative pressures.

Ghei, Kiguel and O'Connell (1997) question the effectiveness of parallel exchange rates. They conclude that their ability to insulate countries from shocks fades over time. They also report that parallel exchange rates systems typically hide structural fiscal problems that ultimately result in higher parallel premiums, and in traumatic unifications. Reinhart and Rogoff (2004) show that it is almost a rule that multiple exchange rate systems end in traumatic devaluation episodes that precede the foreign exchange market unification. Kamin (1997) studies multiple exchange rates in Argentina from 1982 to 1989. He claims that the government chose controls without implementing a fiscal adjustment, deepening the crisis that ended in the hyperinflation of the late 80's. Kaminsky (1997) studies the Mexican experience with parallel rates from 1982 to 1987, and evaluates their ability to insulate domestic prices. She finds that the dual exchange rate system failed to insulate domestic prices. She also finds that parallel exchange rate systems didn't have

any effect on capital outflows. Avellán (2005) reports that multiple exchange rate systems hurt economic performance, measured by annual GDP per capita growth.

The question of the effectiveness of capital controls is empirical in nature, because theory predicts ambiguous results, and the evidence so far is inconclusive. In the next sections I will concentrate on multiple exchange rate systems and their impact on capital flows.

2.3 Why Parallel Rates Might Trigger Capital Outflows?: The "Signaling Effect"

As stated earlier, parallel exchange rate systems constitute a form of capital control on outflows. Bartolini and Drazen (1997) and Drazen (1997) develop a model that may explain why capital controls on outflows could increase capital flight. In their contribution they originally study why capital account liberalization policies trigger capital inflows, but their model is also useful to study the effects of capital controls. Their main message is that current policy decisions are important because they signal the type of decisions the government will take in the future.

Their argument goes as follows. Suppose that the government chooses in every period whether it will allow free capital mobility or set capital controls before investors make their investment decisions. If the government imposes capital controls in any period, it suffers the fixed cost ξ. Suppose also that the government has a good reason to set capital controls, for example, to widen its tax base as was originally assumed by Drazen. Assume that the government's preferences for capital

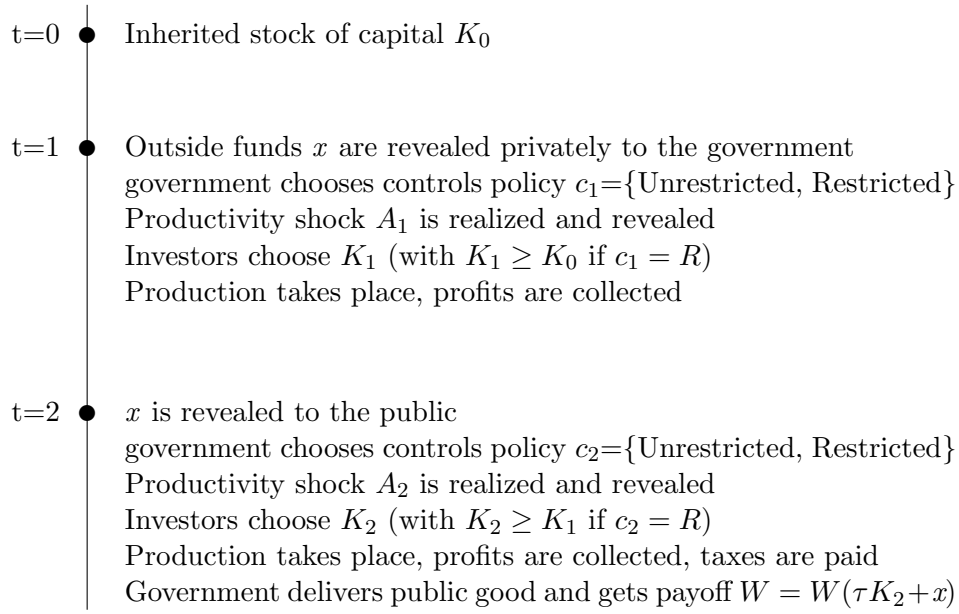

Figure 2.1: Drazen's (1997) Model Sequencing

controls is private information in t=1, but is revealed to investors in t=2. After the government announces its capital mobility policy for a given period, a productivity shock arrives, agents make their investment decision and production takes place. In the last period the government taxes existing capital and receives its payoff. Figure 2.1 reproduces the sequencing of events in Drazen's model. A more detailed exposition of this model is located in the appendix.

The existence of asymmetric information regarding the government's type induces investors to look at current policy choices to form an expectation about what policymakers will decide in the future. The belief about the likelihood of observing capital controls enables investors to form an expectation on the return they will get if they decide to invest in the domestic economy. When agents make their investment decisions, they compare the expected return from the domestic economy to the return they would get in international markets. If the government chooses

market friendly policies (without capital controls), it is likely that it will continue to choose them in the future (current good policy signals future good policy), and hence capital flows will increase. This is the standard statement to explain why capital account liberalization triggers capital inflows. By the same token, if the government chooses capital controls, it is more likely it will continue to do so in the future, so the expected return on domestic capital will decrease and hence foreign assets will become more attractive. Equation (A.10) in the appendix shows formally how an increase in the likelihood of observing capital controls leads to a reduction in capital flows.

The "signaling effect" is an appealing story that rationalizes why capital controls may increase capital outflows. Empirical evidence supports this result. Glick and Hutchison (2000) examine whether capital controls on outflows, aimed at stopping hot money, are effective or just signal "bad policy". They find that restrictions to capital mobility increase the probability of a speculative attack to the domestic currency. This result suggests that restrictions on capital mobility send a bad signal, making the economy more vulnerable to a currency crisis. However, this study didn't consider the endogeneity of the capital mobility policy or unobserved time-invariant country heterogeneity. Cardoso and Goldfajn (1997) study the determinants of capital flows to Brazil, explicitly considering the endogeneity of capital controls. They find that capital controls change the composition and volume of capital flows. Avellán (2005) also explicitly considers the endogeneity of capital controls. He studies the effects of multiple exchange rates on economic performance, measured by GDP per capita growth. He finds that parallel exchange rates reduce economic

performance, as the signaling literature predicts.

2.4 Crises, Parallel Rates and Capital Outflows: A First Pass at the Data

The data sources for this chapter are Reinhart and Rogoff's (2004) appendix, the International Financial Statistics, the World Economic Outlook and the World Economic Indicators databases. The data frequency is annual.

First, to establish some basic stylized facts I split net capital flows[3] data between periods with and without parallel rates. I have 1,116 observations for 46 countries from 1974 to 2001. Figure 2.2 plots their densities. The distribution for the net capital flows/GDP ratio with multiple exchange rates is shifted to the left, suggesting that countries with multiple rates experience lower average net capital flows as a fraction of their GDP than countries with unitary exchange rates. The figure also shows that the distribution of net capital flows/GDP with unitary exchange rates has fatter tails than the capital flows distribution with multiple exchange rates, indicating that capital flows are more volatile without parallel exchange rate systems. Table 2.1 corroborates this observations. It displays descriptive statistics for the net capital flows-GDP ratio and shows that mean net capital flows as a fraction of GDP are equal to -0.005% for the multiple rates case and equal to 1.49% for the other. More formally, I reject in Table 2.2 the hypothesis that mean capital flows are equal with and without multiple rates at the 1% significance level. Table 2.1 also

[3]In this chapter positive capital flows correspond to capital inflows, whereas negative flows to capital outflows.

shows that the capital flows/GDP ratio is more volatile with unitary exchange rates (a standard deviation of 5.74) than with parallel rates (4.34). I reject in Table 2.3 the hypothesis that the capital flows/GDP ratio has the same standard deviation with and without parallel rates at the 1% significance level.

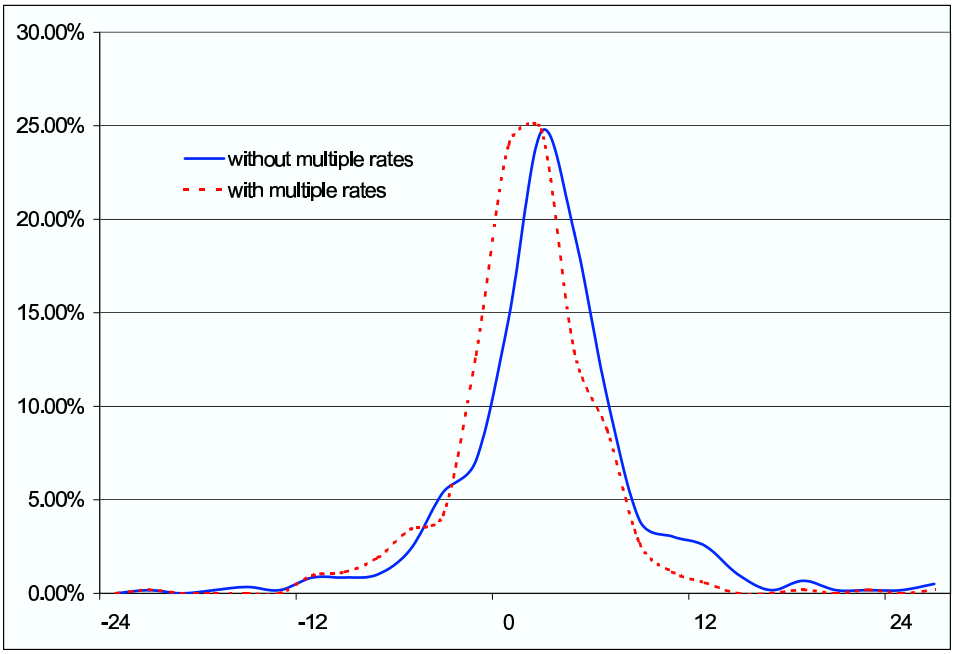

Figure 2.2: Net Capital Flows/GDP Density. Sample of 46 countries, 1,116 observations, 1974-2001.

Next, I look at the behavior of capital flows around crisis periods, adopting an event-study approach. If multiple rates are a successful instrument to stop capital outflows, then countries with parallel rates should not experience significant capital outflows in crisis periods. To explore this point I look at average and median capital flows as a fraction of GDP in six year windows centered around crisis episodes. A natural question is then how to define a crisis episode. To make the study as comprehensive as possible, I use six crises definitions that are common in the literature. These definitions include different measures of currency crisis, default crisis and

banking crisis[4]. To make countries comparable, I take away any "country effect" by demeaning the capital flows series by country for each crisis episode.

Figures 2.3 and 2.4 plot average and median capital flows/GDP ratios for all six crises definitions. It seems that there is no beneficial impact on the behavior of the capital flows/GDP ratio with multiple exchange rates when facing debt crises, currency crises or banking crises, although it seems that there might be some gains in terms of volatility.

The descriptive analysis taken so far does not prove that multiple exchange rates decrease capital flows. Estimating the effects of multiple exchange rate systems on capital outflows is not an easy task because of simultaneity problems. For example, it is possible that once countries experience capital outflows, they impose multiple exchange rate systems to stop them; but it is also possible that the introduction of multiple exchange rates signals international investors that worse times are coming (bad policy signaling), so they run for safer assets abroad. To establish a causal link from multiple exchange rates to capital flows it is necessary to explicitly deal with this endogeneity problem. To the best of my knowledge, very few studies have taken this point into consideration.

Data availability reduces the sample for the econometric study to 518 observations including 46 developing countries for the 1980-2001 period. In this sample 20 countries switch from multiple exchange rate systems to unified exchange rates, 13 countries switch from unified exchange rates to parallel exchange rate systems,

[4]The crisis definitions adopted in this chapter are: default crisis (Standard & Poor), debt crises (Detriagache & Spilimbergo), currency crisis (Kaminsky & Reinhart), banking crisis (Kaminky & Reinhart), (Caprio & Klingbiel) and (IMF).

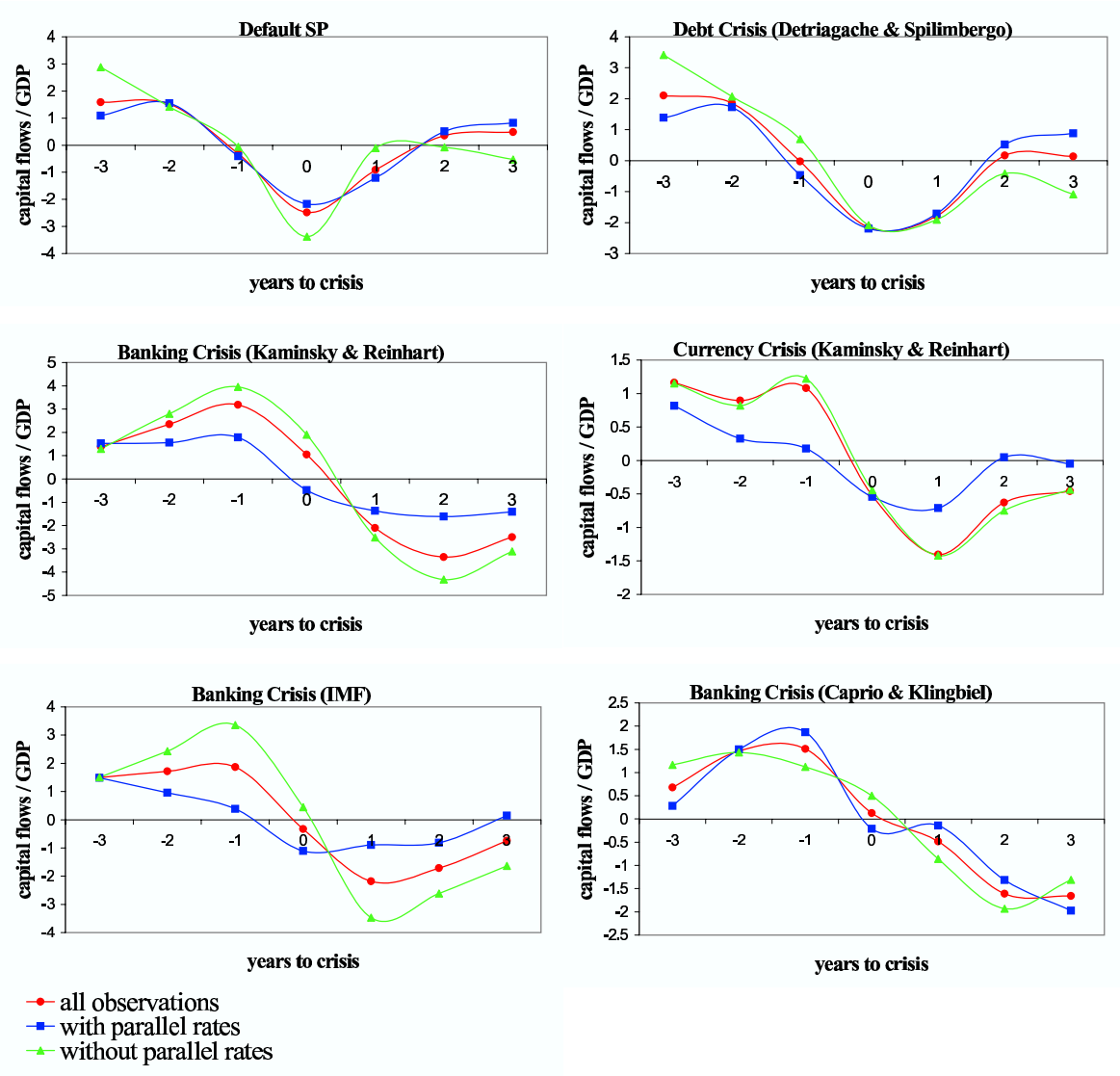

Figure 2.3: Capital Flows/GDP (Averages) and Crisis

15 countries never segment their foreign exchange market, 6 countries always experience parallel exchange rates and 8 countries experience more than one transition. Within this last group of countries, 2 countries switch back to parallel rates, 4 countries switch back to unified rates and 2 countries experience three transitions, from multiple to unified rates.

In the next section I will measure the impact of parallel exchange rates on

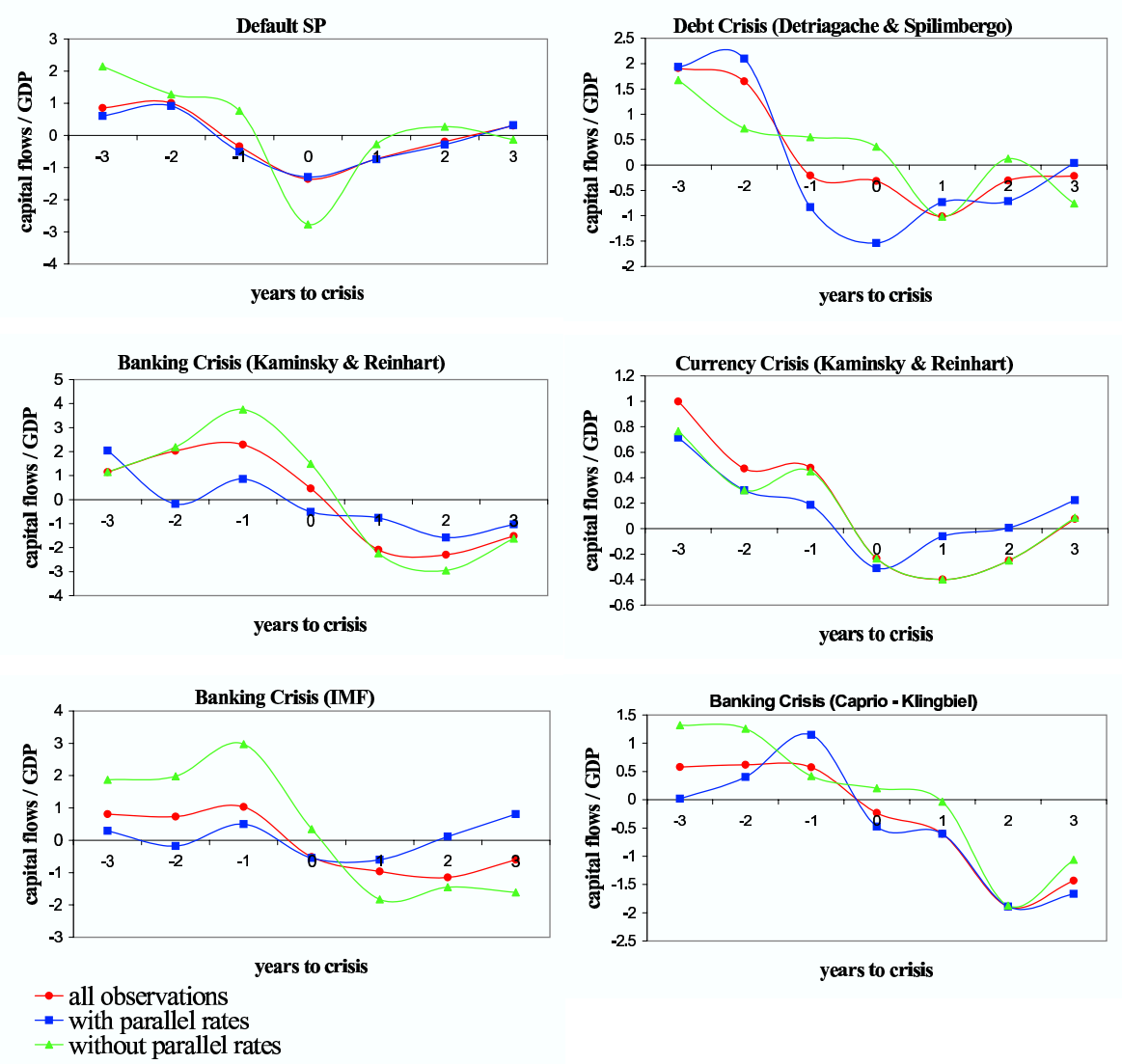

Figure 2.4: Capital Flows/GDP (Medians) and Crisis

capital outflows using instrumental variables and dynamic panel data techniques to address reverse causality problems, among other things.

2.5 Empirical Methodology and Estimation Results

To assess the effectiveness of multiple rates in stopping capital outflows, I estimate a capital flow equation using annual data for 45 developing countries, in

the 1980-2001 period. The specification for the capital flows equation follows the pull and push factors literature. Montiel and Reinhart (1999) define pull factors as "factors that operate through improvements in the risk-return characteristics of assets issued by developing-country debtors..." and push factors as "those that operate by reducing the attractiveness of lending to industrial country debtors." The capital flows equation I estimate is:

$$cf_{i,t} = \gamma_0 + \gamma_1 pull_{i,t} + \gamma_2 push_{i,t} + \varepsilon_{i,t} \tag{2.1}$$

where $cf_{i,t}$ is net capital flows for country i in period t as a fraction of its GDP, γ_0 is a constant term, γ_1 is a row vector of parameters to estimate, $pull_{i,t}$ is a column vector of pull factors, γ_2 is a row vector of parameters to estimate, $push_{i,t}$ is a column vector of push factors, $\varepsilon_{i,t}$ is an independent and identically distributed disturbance term.

As pull factors I use the terms of trade index, the output gap, the annual domestic return (devaluation adjusted) on bank deposits, the inflation rate, government's primary balance as a fraction of GDP, openness, institutional quality, net foreign reserves as fraction of GDP and the number of currency crises in a year. To measure the presence of multiple exchange rate systems I specify a dichotomous variable ($multipleXR$) that is equal to one if a country has had multiple exchange

rates for at least 6 months in a given year[5], and zero otherwise[6]. As push factors I use the industrial production indices and government short-term bond yields for the US and the UK[7]. A full description of the regressors is in the appendix.

The main (and often ignored) problem to estimate the effect of parallel rates on capital flows is the reverse causality between multiple exchange rates and capital flows. I use two different techniques to estimate this effect consistently. First I use two stages least squares (2SLS). The main challenge with this approach is to think about possible "external" instruments than can be excluded from the capital flow equation, and that are relevant to the imposition of multiple exchange rate systems. Second, I use the dynamic panel data estimator (DPD) introduced by Arellano and Bond (1991), and extended by Arellano and Bover (1995) and Blundell and Bond (1998). In this approach it is necessary to make an assumption about the disturbance's serial correlation process in the capital flows equation. Then the estimator uses lags of the dependent and explanatory variables as "internal" instruments for the endogenous variables.

Additionally, I assume that the pull factors, except the terms of trade, are endogenous. I provide an economic explanation of this assumption in the DPD section below. I also assume that the push factors are strictly exogenous. This is a plausible assumption because developing countries are considered small, and idiosyncratic shocks to capital flows should not have any link with advanced economies' produc-

[5]The results do not change if I consider a different threshold.

[6]The source of this data is the appendix for Reinhart and Rogoff (2004) "A Modern History of Exchange Rates".

[7]Lines 11160c and 11261 in the International Financial Statistics. I use short term rates because they are more sensible to changes in the economic environment.

tion or interest rates, or worldwide commodity prices, at any lead or lag.

An Instrumental Variables Approach

In this section I use 2SLS to measure the causal impact of multiple exchange rate systems on capital flows. To isolate the endogeneity of multiple exchange rate systems and to avoid additional simultaneity problems, all the pull factors except the terms of trade and the multiple exchange rates variable have been lagged one period[8].

As discussed in Chapter 1, countries that choose to introduce multiple exchange rates systems fear that a unified devaluation might trigger an inflation spike or countrywide bankruptcies because of balance sheet effects due to liability dollarization. I will use the shares of manufactures and fuel in total imports as instruments, because countries with higher shares are more likely to implement multiple exchange rate systems due to the fact that they would suffer a higher pass-through effect if they implemented a unified devaluation[9]. To capture the balance sheet effect, I will use as instrument the share of foreign debt denominated is US dollars and I will use the share of short term debt in external debt as a measure of liquidity risk. These two variables capture the liability dollarization channel and the liquidity

[8]A similar econometric strategy, but in a different context, is followed by Calvo, Izquierdo and Mejía (2004), Claessens, Klingebiel and Schmukler (2003), Garibaldi, Mora, Sahay and Zettelmeyer (2001), among others. The DPD section presents an alternative technique to deal with the endogeneity of the pull factors.

[9]Bailliu and Bouakez (2004) argue that "the extent to which those changes (changes in import prices due to exchange rate movements) are reflected in the consumer price index (CPI) depends on the share of imports in the consumption basket". Data on the share of imports in the consumption basket is not available, so I use the shares of manufactures and fuel in total imports as proxies. See Campa and Goldberg (2002) and Goldberg and Knetter (1997) for a discussion on why the degree of pass-though differs across countries and across time.

risk that may push firms into insolvency if a unified devaluation takes place. When countries' external debt maturity is short, and when the currency mismatch in liabilities is high, segmenting the foreign exchange market becomes attractive because the impact of the devaluation on firms' balance sheets would not be as high as if the devaluation were unitary. To make sure that the instruments have no direct effect on capital flows, I lag them one period. Then, the underlying exclusion restriction is that the one period lags of the instruments have no impact on capital flows other than their indirect effect through the segmentation of the foreign exchange market.

Estimation Results

Table 2.5 shows the estimation results for equation (2.1). The OLS estimates suggest that having multiple exchange rate systems reduces capital flows by 2.2% of GDP, and is significant at the 1% level. However, as stated previously, this result is contaminated by reverse causality, affecting OLS consistency. The 2SLS estimates suggest then that parallel exchange rate systems reduce capital flows by 4.5% of GDP at the 10% significance level. I also find that good fiscal performance *(budbal)* increases net capital inflows by 0.17% of GDP at the 1% significance level, while currency crisis *(crisisperyear)* decreases net capital flows by 1.97% of GDP at the 1% significance level . Table 2.6 shows the results for the first stage regression. The instruments are jointly significant, and three out of four instruments are individually significant. The first stage results suggest that the degree of currency mismatch (liability dollarization), measured by the currency composition of long term debt, is

positively related to the likelihood of observing parallel rates. The share of fuel in total imports and the share of short term debt in external debt are significant but with negative sign. Notice that there is overidentification when I estimate equation (2.1) by 2SLS because there are four instruments and just one endogenous variable. The overidentifying restriction test in Table 2.5 shows that I fail to reject the validity of the instruments.

As an additional specification test, I re-estimate equation (2.1) but adding 2 leads and 2 lags of the multiple exchange rates measure. This approach is a kind of specification test because if multiple rates are having a causal impact on net capital flows, the effects should not show up until after the regime changes[10]. So if the instruments are valid, there shouldn't be any significant lead effect. Table 2.7 displays the estimation results and shows that the lead effects are not significant.

The 2SLS procedure to this point has estimated the first stage regression using plain OLS[11]. Maddala (1983) suggests a modification to this procedure when the endogenous variable is dichotomous, as is the case here. His suggestion consists in instrumenting the controls measure using a probit model, and then using the fitted values in the capital flows equation. The fifth and sixth columns in Table 2.5 show the estimation results from applying this method and indicate that parallel exchange rate systems have no impact on capital outflows.

The results obtained so far with instrumental variables reveal that multiple

[10]I would like to thank John Shea for suggesting this approach.

[11]This is equivalent to say that I have used a linear probability model in the first stage regression to estimate the likelihood of observing parallel exchange rates. The main shortcoming of the linear probability model is that the predicted probabilities are not constrained to be within the [0,1] interval.

exchange rate systems are ineffective at best at stopping capital outflows[12], and at worst they might increase capital outflows.

A Dynamic Panel Data (DPD) Approach

In this section I will use DPD estimators to look further into the effectiveness of multiple exchange rates systems. In particular, this technique allows me to handle the endogeneity of the pull factors explicitly because the DPD estimator instruments for all endogenous variables in the model. Besides, DPD lets me consider a richer dynamic framework, in which there might be some persistence in capital flows together with country specific effects. Then, the capital flow equation I estimate is:

$$\begin{aligned} cf_{i,t} &= \gamma_0 + \gamma_1 pull_{i,t} + \gamma_2 push_{i,t} + \eta_i + \upsilon_{i,t} \\ \upsilon_{i,t} &= \rho \upsilon_{i,t-1} + \varepsilon_{i,t} \\ &\mid \rho \mid < 1 \end{aligned} \tag{2.2}$$

where $cf_{i,t}$ are net capital flows for country i in period t as a fraction of its GDP, γ_1 is a row vector of parameters to estimate, $pull_{i,t}$ is a column vector of pull factors, γ_2 is a row vector of parameters to estimate, $push_{i,t}$ is a column vector of push factors, η_i is an unobserved country specific effect, $\upsilon_{i,t}$ is a disturbance that may be serially correlated and $\varepsilon_{i,t}$ is a disturbance term. I assume that $\eta_i \sim iid(0, \sigma_\eta^2)$

[12]This result doesn't change if I introduce country fixed effects.

and $\varepsilon_{i,t} \sim iid(0, \sigma_{\varepsilon}^2)$ across i and t. I also assume that $\varepsilon_{i,t}$ and η_i are independent of each other.

This model has a dynamic representation as in (2.3):

$$\begin{aligned} cf_{i,t} &= (1-\rho)\gamma_0 + \gamma_1 pull_{i,t} - \rho\gamma_1 pull_{i,t-1} + \gamma_2 push_{i,t} - \rho\gamma_2 push_{i,t-1} + \rho cf_{i,t-1} + \omega_{i,t} \\ \omega_{i,t} &= (1-\rho)\eta_i + \varepsilon_{i,t} \end{aligned} \tag{2.3}$$

or

$$\begin{aligned} cf_{i,t} &= \pi_0 + \pi_1 pull_{i,t} + \pi_2 pull_{i,t-1} + \pi_3 push_{i,t} + \pi_4 push_{i,t-1} + \pi_5 cf_{i,t-1} + \omega_{i,t} \\ \omega_{i,t} &= \eta_i^* + \varepsilon_{i,t} \end{aligned} \tag{2.4}$$

where $(1-\rho)\gamma_0 \equiv \pi_0$ and $(1-\rho)\eta_i \equiv \eta_i^*$.

Equation (2.4) uses less information than equation (2.3) because it does not reflect the parameter restrictions. The estimation of equation (2.4) has at least two complications. First, the assumption about the endogeneity of the current value of the pull factors results in time varying correlation between the disturbance term and the pull factors so that $E[pull_{i,t} \cdot \varepsilon_{i,t}] \neq 0$. This could be the case if, for instance, an increase in capital inflows translates into an increase in foreign reserves and domestic inflation, as would happen under a highly managed exchange rate regime. It could also be the case that central banks may want to sterilize capital

inflows by increasing domestic interest rates. Second, the country specific effect is correlated with the endogenous right hand side variables, so that $E[pull_{i,t} \cdot \eta_i^*] \neq 0$ and $E[\eta_i^* \cdot cf_{i,t-1}] \neq 0$. Using OLS under these circumstances results in inconsistent estimates. Because of these problems, I take the first difference of equation (2.4) to remove the country specific effect and obtain the following expression:

$$\begin{aligned} \Delta cf_{i,t} &= \pi_1 \Delta pull_{i,t} + \pi_2 \Delta pull_{i,t-1} + \pi_3 \Delta push_{i,t} + \pi_4 \Delta push_{i,t-1} + \pi_5 \Delta cf_{i,t-1} + \Delta \omega_{i,t} \\ \Delta \omega_{i,t} &= \varepsilon_{i,t} - \varepsilon_{i,t-1} \end{aligned} \tag{2.5}$$

Equation (2.5) is the main estimating equation. However, notice that $\Delta \omega_{i,t}$ is correlated with $\Delta cf_{i,t-1}$ and notice also that the pull factors' endogeneity problem remains unsolved[13]. Therefore, using OLS to estimate equation (2.5) produces inconsistent estimates. Arellano and Bond (1991) and Arellano and Bover (1995) show large sample results for a GMM procedure to estimate dynamic panel data models like the one presented above. Their estimator uses suitable lags of the explanatory and dependent variables as "internal" instruments to estimate equation (2.5). This estimator is known as the "Difference GMM" estimator.

Nevertheless, Blundell and Bond (1998) show that this estimator has poor small sample properties when the instruments are "weak". They show that this happens when the processes of the explanatory variables are highly persistent or are close to a random walk. Blundell and Bond (1998) solve this problem adding

[13]It can be shown that $E[\Delta \omega_{i,t} \cdot \Delta pull_{i,t}] \neq 0$ and that $E[\Delta \omega_{i,t} \cdot \Delta pull_{i,t-1}] \neq 0$.

extra orthogonality conditions to the "Difference GMM" estimation[14]. This additional moment conditions rely on a set of stationarity assumptions, and exploit the orthogonality between the first differences of the explanatory variables and the disturbance term in equation (2.4). This extended estimator is known as the "System GMM" estimator.

It is important to highlight that the assumption regarding the autoregressive order of the disturbance term in equation (2.2) is fundamental to estimate equation (2.5) consistently with DPD. If $\upsilon_{i,t}$'s autoregressive order is greater than 1, the model would be misspecified and the estimates would not be consistent. Fortunately, I can statistically test this assumption to make sure that the model is correctly specified.

Then, if $\upsilon_{i,t}$ has first order serial correlation, the push factors are exogenous and the pull factors are endogenous, the following orthogonality conditions hold:

$$\begin{aligned} E[push_{i,s} \cdot (\varepsilon_{i,t} - \varepsilon_{i,t-1})] &= 0 \qquad (2.6) \\ & \quad t \geq 2, \forall s \\ & \quad i = 1, 2, \ldots N \end{aligned}$$

[14]Blundell and Bond (1998B) apply this method to the estimation of production functions for the US manufacturing sector.

Also,

$$E[pull_{i,t-s} \cdot (\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \quad (2.7)$$

$$E[cf_{i,t-s} \cdot (\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \quad (2.8)$$

$$t = 3, 4, \ldots T$$

$$s = 2, 3, \ldots T$$

$$i = 1, 2, \ldots N$$

$$E[\Delta push_{i,t-1} \cdot (\eta_i^* + \varepsilon_{i,t})] = 0 \quad (2.9)$$

$$E[\Delta pull_{i,t-1} \cdot (\eta_i^* + \varepsilon_{i,t})] = 0 \quad (2.10)$$

$$E[\Delta cf_{i,t-1} \cdot (\eta_i^* + \varepsilon_{i,t})] = 0 \quad (2.11)$$

$$t = 3, 4, \ldots T$$

$$i = 1, 2, \ldots N$$

Note that (2.8) follows from (2.6) and (2.7), and (2.11) follows from (2.9) and (2.10). To compute the "Difference GMM" estimator I use the orthogonality conditions given by equations (2.6) to (2.8), and to compute the "System GMM" estimator I use the moment conditions given by equations (2.6) to (2.11). The first condition comes from the push factors' exogeneity. The second and third conditions are a consequence of the first order serial correlation assumption on $\upsilon_{i,t}$ and the pull factors' endogeneity. The remaining orthogonality conditions hold under the

following stationarity assumptions:

$$E[pull_{i,t+p} \cdot \eta_i^*] = E[pull_{i,t+q} \cdot \eta_i^*] \quad (2.12)$$

$$E[push_{i,t+p} \cdot \eta_i^*] = E[push_{i,t+q} \cdot \eta_i^*] \quad (2.13)$$

$$E[cf_{i,t+p} \cdot \eta_i^*] = E[cf_{i,t+q} \cdot \eta_i^*] \quad (2.14)$$

$$\forall p, q$$

Where (2.12) and (2.13) imply (2.14).

The "Difference GMM" and the "System GMM" estimators must pass two crucial tests to make sure that the estimates are consistent. First, the instruments I am using should be valid. Notice that there is overidentification because the number of instruments exceeds the number of endogenous variables. Arellano and Bond suggest the Sargan test of overidentifying restrictions to test if the instruments are valid. The literature shows that the Sargan statistic is not robust to heteroskedasticity or autocorrelation (Hayashi 2000), so I present the Hansen J statistic for the overidentifying restrictions test, which is robust. Second, if the model is correctly specified the disturbance term in (2.5) should not have second order serial correlation (notice that by construction first order correlation is expected). If I reject the null hypothesis of no second order serial correlation, it indicates that I am using as instruments lags of the explanatory variables that in fact are endogenous. Then I should include more lags of the explanatory variables, and of the dependent variable as well, in equation (2.4) to correctly specify the model.

Estimation Results

The results for the "Difference GMM" and the "System GMM" estimators appear in Table 2.8. First, notice that as expected for both estimators, I reject the null hypothesis of no first order serial correlation at the 5% and 1% significance levels. Second, I fail to reject the null hypothesis of no second order serial correlation, which denotes that the model has been correctly specified. I also fail to reject the null hypothesis that the instruments are valid. All these results imply that I am consistently estimating the model.

The Difference GMM estimation finds that multiple rates decrease capital flows by 2.3% of GDP at the 5% significance level. This implies that the adoption of these type of capital controls is not only ineffective, but harmful, because it increases capital outflows. Economic turmoil also reduces capital flows. Currency crises increase capital outflows by 1.4% of GDP. Higher domestic returns have a positive -though small- impact on capital flows. The estimate of ρ, which measures capital flows persistence, is positive and significant at the 1% level.

As noted earlier, Difference GMM could have poor performance in small samples if the instrument series are persistent. To check the robustness of the results obtained so far, the third and fourth columns in Table 2.8 display the results for the System GMM estimation. The main findings are that multiple exchange rate systems decrease capital flows by 1.9% of GDP, and that currency crises also reduce capital flows, but by 1.3% of GDP. The autocorrelation coefficient for capital flows is positive and significant at the 1% level.

The results obtained using DPD suggest that multiple exchange rate systems trigger capital outflows, rather than stopping them. This result is robust to endogeneity, and to the presence of unobserved country effects.

2.6 Chapter 2: Conclusions

In this chapter I measure the effectiveness of multiple exchange rates systems as a tool to stop capital outflows, considering explicitly the endogeneity of capital controls. I look at 46 developing countries in the 1980-2001 period. The main result is that multiple exchange rates are an ineffective tool to stop capital outflows. A first pass at the data suggests that countries with multiple exchange rates have lower capital flows on average than countries with unitary exchange rates. Preliminary evidence proposes that capital flows are more volatile in countries where the exchange rate is unitary in contrast with countries with parallel exchange rate systems. I also look at capital flows dynamics with and without parallel exchange rates systems before and after debt, currency and banking crisis episodes. In all cases, I cannot find compelling support for the claim that multiple exchange rates stop capital outflows. For every kind of crisis, capital flows recurrently decline in crisis periods, though it seems that capital flows swings are less pronounced with multiple exchange rates.

Using a more rigorous econometric framework, I find that, at best, multiple exchange rates have no impact on capital flows. At worst, the evidence suggests that parallel exchange rate systems trigger capital outflows instead of stopping them.

This last result could be rationalized with a standard signaling model for capital controls.

The policy implication of the estimation results, is that policymakers should be aware that segmenting the foreign exchange market will reinforce capital outflows rather than stop them.

This chapter can be extended in a number of ways. Section 2.4 presents some preliminary descriptive evidence that capital flows are less volatile under multiple exchange rate systems. A potential extension is to take this point further and measure the impact of parallel exchange rates on capital flows volatility, considering not only the endogeneity of parallel exchange rates, but also the relationship between capital flows' mean and volatility. This is an interesting approach because there seems to exist a tradeoff between enjoying higher capital flows but with with higher volatility, or having lower capital flows but with less volatility.

Another research avenue to explore is the role of contagion. This chapter has not considered the possibility that the imposition of parallel exchange rates spills over from one country to another as countries get hit by shocks to the capital account. Capital flows reversals may be spatially correlated, and hence it may pay off to look at the effects of multiple exchange rates under this perspective.

2.7 Appendix

Appendix I: Drazen's (1997) Capital Controls Model

In this section I present a detailed exposition of Drazen's (1997) model, which is the theoretical framework that supports some of the empirical results presented in this chapter[15]. Assume that there are 2 periods. In each period, risk neutral investors have to decide whether or not to invest their capital in international markets and get the return given by the international interest rate r, or invest in the domestic technology given by equation (A.1) and earn the marginal product of capital.

$$Y_t = A_t K_t^{\alpha}, 0 < \alpha \leq 1, t = 1, 2 \tag{A.1}$$

Output is subject to the productivity shock A_t. It is assumed that A_t can take two possible values: $\overline{A}$ with probability π and 0 with probability $1 - \pi$, where $\overline{A} > 0$. The government chooses its capital mobility policy, c_t, which may be either restricted (capital controls, R) or unrestricted (free capital mobility, U).

The timing of events for the model is reproduced in Figure 2.1 from Drazen (1997), and is as follows. In period one, the government learns privately its type $x \epsilon \{x^l, x^h\}$ where $x^l < x^h$ and where x captures exogenous fiscal revenue available besides capital taxation. The government chooses its capital mobility policy c_1. Then the productivity shock A_1 arrives, investment decisions take place, production occurs according to (A.1) and profits are collected. At the beginning of period

[15]For a general version of this model see Bartolini and Drazen (1997), where they consider a continuum of types, and more general functional forms as well. Drazen (1997) builds on Bartolini and Drazen (1997) and delivers a more tractable model. I use the latter in this section.

two, government's type is revealed to investors. Next, the government decides its capital mobility policy c_2, followed by the productivity shock. Then investors make their investment decisions, and production occurs. At the end of period two, the government levies a proportional publicly known tax τ over the existing capital stock, spends $\tau K_2 + x$ and derives utility $W(\tau K_2 + x)$ where $W(\cdot)$ is a standard concave utility function. Investors discount profits at the rate ρ. If the government imposes capital controls in any period, it suffers the fixed cost ξ.

The model is solved backwards. In the last period investors get the return $1 + r$ if they invest abroad, or they get $\alpha A_2 K_2^{\alpha-1} + (1 - \tau)$, the marginal product of capital plus the after tax capital stock , if they choose the local technology and if $A_2 = \overline{A}$ [16]. Under free capital mobility, risk neutral international investors will invest domestically until the point that both marginal returns are equalized, as in equation (A.2)

$$1 + r = \alpha A_2 K_2^{\alpha-1} + (1 - \tau) \tag{A.2}$$

Solving (A.2) for K_2 provides the expression for second period capital stock under free capital mobility, as a function of the second period productivity shock.

$$K_2(A_2) = \left(\frac{\alpha A_2}{r + \tau} \right)^{\frac{1}{1-\alpha}} \tag{A.3}$$

If the government imposes capital controls in t=2, the second period capital

[16] If there is a bad productivity shock ($A_2 = 0$) in the domestic economy, investors will set $K_2 = 0$ and will invest all of their resources in the riskless international technology.

stock will be constrained by

$$K_2 \geq K_1 \tag{A.4}$$

Next, the government chooses its capital mobility policy before observing the realization of A_2. When making its decision, the government chooses the policy that yields the highest expected payoff. Letting $\psi_2(K_1, x)$ be the difference between the expected payoff from setting capital controls and the expected payoff from setting free capital mobility, then:

$$\psi_2(K_1, x) \equiv E_2[W(\tau K_2 + x)|K_1, c_2 = R] - \xi - E_2[W(\tau K_2 + x)|K_1, c_2 = U] \tag{A.5}$$

So the government will choose to establish capital controls whenever $\psi_2(K_1, x) > 0$, and will choose free capital mobility whenever $\psi_2(K_1, x) \leq 0$. Now, as in Drazen (1997), assume that the capital controls restriction doesn't bind in the high productivity state, so $K_2(\overline{A}) > K_1$, and let the government's payoff function be $W(\cdot) = ln(\cdot)$. Then (A.5) can be written as:

$$\psi_2(K_1, x) = \pi ln(\tau K_2(\overline{A}) + x) + (1-\pi) ln(\tau K_1 + x) - \xi - \pi ln(\tau K_2(\overline{A}) + x) - (1-\pi) ln(x) \tag{A.6}$$

Which reduces to:

$$\psi_2(K_1, x) = (1-\pi)[ln(\tau K_1 + x) - ln(x)] - \xi \tag{A.7}$$

Notice that (A.7) is decreasing in x. That means that there is a unique value of x such that given K_1, $\psi_2(K_1, \overline{\overline{x}}) = 0$. So for a given value of K_1, the government chooses capital controls if $x < \overline{\overline{x}}$, and chooses free capital mobility if $x \geq \overline{\overline{x}}$.

In period 1, investors choose K_1. As in the second period, investors compare the expected return from investing onshore with the expected return from investing offshore. When making their decision, investors do not know the government's capital mobility policy in the second period, but observe the capital mobility policy set in the first period, and form a belief about the probability $\gamma_1^{c_1}$ of observing capital controls in t=2, given c_1.

The marginal expected domestic return for an investor in $t = 1$ when $A_1 = \overline{A}$ is:

$$V_1(K_1; \gamma_1^{c_1}, A_1 = \overline{A}) \equiv \overline{A}\alpha K_1^{\alpha-1} + (1 - \gamma_1^{c_1} + \gamma_1^{c_1}\pi)\rho(1+r) + (1-\pi)\gamma_1^{c_1}\rho(1-\tau) \tag{A.8}$$

Risk neutral investors equalize the expected domestic return with the international return, so

$$V_1(K_1; \gamma_1^{c_1}, A_1 = \overline{A}) = r + \rho(1+r) \tag{A.9}$$

Solving (A.9) for K_1, it is possible to show that:

$$K_1 = \left(\frac{\alpha A_1}{r + \rho(1-\pi)\gamma_1^{c_1}(r+\tau)} \right)^{\frac{1}{1-\alpha}} \tag{A.10}$$

Equation (A.10) shows that the more likely investors believe that there will be capital controls (the higher $\gamma_1^{c_1}$), the lower K_1.

Finally, the government will choose in t=1 the capital mobility policy that yields the highest expected payoff. Letting $\psi_1(K_0, x)$ be the difference between the expected payoff from setting capital controls ($c_1 = R$) and the expected payoff from setting free capital mobility ($c_1 = U$), then:

$$\psi_1(K_0, x) = \rho E_1[ln(\tau K_2 + x | c_1 = R) - ln(\tau K_2 + x | c_1 = U)] - \xi - \rho\xi I \tag{A.11}$$

Where $I \equiv I(c_2 = R)$ is an indicator function that is equal to one when capital controls are imposed in period two. Equation (A.11) is decreasing in x[17], so there exists a value $\overline{x}$ such that $\psi_1(K_0, \overline{x}) = 0$. This result suggests that in equilibrium, governments with $x < \overline{x}$ choose capital controls and governments with $x \geq \overline{x}$ choose free capital mobility in period one.

The intuition behind this result is that when exogenous fiscal revenue is scarce (low x), the government will impose capital controls in both periods to trap foreign capital and use it as a source of revenue to finance its expenditures. Nevertheless,

[17]Bartolini and Drazen (1997) provide a general result for any concave payoff function. Drazen (1997) presents a numerical example for equation (A.11) where he shows that for low values of x, the government chooses to impose restrictions on capital mobility in both periods, whereas for high values of x, the government follows a free capital mobility policy in both periods. He also shows that for some values of x, the government chooses free capital mobility in t=1, and chooses capital controls in t=2.

imposing capital controls in period one increases the likelihood of observing capital controls in period two, and investors will allocate less capital in the domestic economy, decreasing revenue that could be raised from capital taxation. But the government will accept this consequence and choose capital controls when revenue from other sources is negligible or not available. On the other hand, when exogenous fiscal revenue is abundant (high x), the government will choose free capital mobility in both periods.

Appendix II: Crisis Definitions

Default Standard & Poor's

Sample: Argentina 1982, Argentina 1989, Bolivia 1980, Bolivia 1986, Brazil 1983, Brazil 1986, Brazil 1989, Chile 1983, Costa Rica 1981, Costa Rica 1983, Dominican Republic 1982, Ecuador 1982, Ecuador 1999, Egypt, Arab Rep. 1984, El Salvador 1981, Gambia, The 1986, Ghana 1987, Guatemala 1986, Guatemala 1989, Guinea 1986, Guyana 1979, Guyana 1982, Haiti 1982, Honduras 1981, Indonesia 1998, Jamaica 1978, Jordan 1989, Mexico 1982, Morocco 1983, Nicaragua 1979, Nigeria 1982, Nigeria 1986, Nigeria 1992, Pakistan 1998, Panama 1983, Panama 1987, Paraguay 1985, Peru 1978, Peru 1980, Peru 1984, Philippines 1983, Romania 1981, Russian Federation 1998, Senegal 1981, Senegal 1990, South Africa 1985, South Africa 1989, South Africa 1993, Tanzania 1984, Turkey 1978, Turkey 1982, Uruguay 1983, Uruguay 1990, Venezuela, RB 1983, Venezuela, RB 1990, Venezuela, RB 1995, Zambia 1983.

Debt Crisis (Detriagache and Spilimbergo)

Sample: Argentina 1983, Brazil 1983, Burundi 1986, Chile 1983, Colombia 1985, Costa Rica 1981, Dominican Republic 1976, Dominican Republic 1982, Ecuador 1983, Egypt, Arab Rep. 1986, El Salvador 1984, El Salvador 1995, Guatemala 1985, Haiti 1983, Honduras 1976, Honduras 1982, Indonesia 1998, Jordan 1989, Korea, Rep. 1998, Lesotho 1990, Mexico 1982, Morocco 1985, Nicaragua 1978, Nigeria 1986, Panama 1987, Paraguay 1984, Peru 1983, Philippines 1984, Senegal 1984, Senegal 1989, Sri Lanka 1992, Thailand 1998, Turkey 1979, Venezuela, RB 1984.

Currency Crisis (Kaminsky and Reinhart)

Sample: Argentina 1981, Argentina 1986, Argentina 1989, Argentina 1990, Bolivia 1982, Bolivia 1983, Bolivia 1985, Brazil 1983, Brazil 1986, Brazil 1989, Brazil 1990, Brazil 1991, Chile 1976, Chile 1982, Chile 1984, Colombia 1983, Colombia 1985, Egypt, Arab Rep. 1979, Egypt, Arab Rep. 1989, Egypt, Arab Rep. 1990, Indonesia 1983, Indonesia 1986, Indonesia 1997, Israel 1974, Israel 1977, Israel 1983, Israel 1984, Korea, Rep. 1980, Korea, Rep. 1997, Malaysia 1975, Malaysia 1997, Mexico 1982, Mexico 1994, Peru 1987, Philippines 1983, Philippines 1984, Philippines 1997, South Africa 1975, South Africa 1981, South Africa 1984, South Africa 1996, Thailand 1978, Thailand 1981, Thailand 1997, Turkey 1980, Turkey 1994, Uruguay 1982, Venezuela, RB 1984, Venezuela, RB 1986, Venezuela, RB 1989, Venezuela, RB 1994, Venezuela, RB 1995.

Banking Crisis (Kaminsky and Reinhart)

Sample: Argentina 1980, Argentina 1985, Argentina 1994, Bolivia 1987, Brazil 1985, Brazil 1994, Chile 1981, Colombia 1982, Colombia 1998, Egypt, Arab Rep. 1980, Egypt, Arab Rep. 1990, Indonesia 1992, Israel 1983, Korea, Rep. 1986, Korea, Rep. 1997, Malaysia 1985, Malaysia 1997, Mexico 1982, Mexico 1992, Peru 1983, Philippines 1981, Philippines 1997, South Africa 1977, Thailand 1979, Thailand 1996, Turkey 1991, Uruguay 1981, Venezuela, RB 1993.

Banking Crisis (Caprio and Klingbiel)

Sample: Argentina 1980, Argentina 1985, Argentina 1995, Bolivia 1986, Brazil 1994, Colombia 1982, Egypt, Arab Rep. 1980, Egypt, Arab Rep. 1990, Indonesia 1994, Israel 1977, Malaysia 1985, Mexico 1981, Mexico 1995, Philippines 1981, South Africa 1977, Thailand 1983, Turkey 1992 , Turkey 1994, Uruguay 1981, Venezuela, RB 1980, Venezuela, RB 1994.

Banking Crisis (IMF)

Sample: Argentina 1980, Argentina 1985, Argentina 1989, Argentina 1995, Brazil 1990, Brazil 1994, Chile 1976, Chile 1981, Colombia 1982, Egypt, Arab Rep. 1981, Egypt, Arab Rep. 1990, Indonesia 1992, Indonesia 1997, Israel 1983, Korea, Rep. 1983, Korea, Rep. 1997 , Malaysia 1985, Mexico 1982, Mexico 1984, Peru 1983, Philippines 1981, South Africa 1980, Thailand 1983, Thailand 1997, Turkey 1982, Turkey 1991, Turkey 1994, Uruguay 1981, Venezuela, RB 1980, Venezuela, RB 1993.

Appendix III: Sources and Definitions of Variables

cf: Private net capital flows as a fraction GDP. Capital flows is equal to the sum of Private Net Equity Securities, Private Net Debt Securities, Private Net Loans, Private Net Currency and Deposits, Private Net Other Investments and Net Errors and Omissions. Source: Professor Carmen Reinhart.

usindprod: US industrial production index. Source IFS.

ustrate: US annual Treasury Bill rate. Source IFS.

ukindprod: UK industrial production index. Source IFS.

ukgovyield: UK annual government's bond yield. Source IFS.

tot: Net barter terms of trade. Source: World Development Indicators 2003.

multipleXR: is a dichotomous variable that takes the value of 1 if for a given year a country has had multipe/dual exchange rates for at least 6 months, and zero otherwise. To build this variable I look at appendixes 1 and 2 in Reinhart and Rogoff (2002) Modern History of Exchange Rates.

gap: is the the fraction of output that is above (below) its long run level, due to cyclical fluctuations. The cyclical component is obtained through applying the Hodrick- Prescott filter to the the annual series of real GDP from the World Development Indicators 2003.

domestic return: is the return obtained within the country, taking into account the devaluation rate. To measure the return in domestic currency I use the IFS deposits rate. The devaluation rate is taken from Reinhart and Rogoff (2004).

inflation: CPI inflation rate. Source: World Development Indicators 2003.

budbal: Primary surplus as a fraction of GDP. Source: World Development Indicators 2003.

openness: is trade openness, where the latter is defined as export plus imports divided by GDP. Source: World Development Indicators 2003.

civil: civil liberties index, ranges from 1 to 7, where 1 is the best score and 7 is the worst. Source: Annual Freedom in the World Country Scores.

netres_gdp: Foreign net reserves as a fraction of GDP. World Development Indicators 2003.

crisisperyear: The crisis per year regressor adds how many times within a year the local currency either experiences a monthly depreciation rate greater than or equal to 12.5% or when the difference from previous month's depreciation rate is greater than or equal to 10%. Source: Prof. Carmen Reinhart.

currcomplt: The percentage of external long-term debt contracted in U.S. dollars for the low- and middle-income countries. Long-term external debt is defined as debt that has an original or extended maturity of more than one year and that is owed to nonresidents and repayable in foreign currency, goods, or services. Source: Global Development Finance 2001.

manufimports: Is the share of manufactures imports in total imports. Manufactures comprise the commodities in SITC sections 5 (chemicals), 6 (basic manufactures), 7 (machinery and transport equipment), and 8 (miscellaneous manufactured goods), excluding division 68 (nonferrous metals). Source: World Development Indicators 2003.

fuelimports: Is the share of fuel imports in total imports. Source: World Development Indicators 2003.

stdebt_xdebt: Short-term debt to total external debt. Source: Global Development Finance 2001.

Appendix IV: Tables

Table 2.1: Net Capital Flows/GDP statistics with and without multiple exchange rate systems

	Obs	**Mean**	**Std. Dev.**	**Min**	**Max**
With multiple rates	525	-0.005	4.338	-23.804	24.913
Without multiple rates	591	1.490	5.744	-22.045	56.976

Sample of 46 countries, 1,116 observations, 1974-2001

Table 2.2: Two Sample t-test of Equality of Means

Ho: means are equal	
Ha: mean with unitary exchange rates>mean with parallel rates	
Variable: capital flows/GDP	
$t_{1,086}$	4.9373
P-value	0.000

Sample of 46 countries, 1,116 observations, 1974-2001

Unequal variances allowed.

Table 2.3: Variance Ratio Test

Ho: Std. Dev. are equal	
Ha: Std. Dev. with unitary exchange rates>Std. Dev. with parallel rates	
Variable: capital flows/GDP	
F_{524}^{590}	1.753
P-value	0.000

Sample of 46 countries, 1,116 observations, 1974-2001

Table 2.4: Effective Sample Descriptive Statistics

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
multipleXR	518	0.388	0.488	0.000	1.000
usindprod	518	89.942	15.504	68.250	123.330
ustrate	518	6.526	2.554	3.020	14.080
ukindprod	518	91.426	9.234	74.270	104.200
ukgovyield	518	9.404	2.421	5.380	14.650
tot	518	106.284	24.706	67.790	262.371
gap	517	-0.506	4.306	-17.920	12.398
domesticreturn	518	22.685	100.809	-19.334	1730.762
inflation	518	70.865	544.788	-0.845	7485.495
budbal	518	-2.774	5.142	-35.561	20.626
openness	518	69.138	34.524	6.320	192.114
civil	518	3.884	1.455	1.000	7.000
nres_gdp	518	11.761	14.815	0.323	104.639
crisisperyear	518	0.197	0.520	0.000	4.000
currcomplt	503	45.641	20.154	0.400	92.700
stdebt_xdebt	503	14.588	9.821	0.564	57.496
fuelimports	442	12.139	9.235	0.319	58.614
manufimports	442	68.650	11.403	37.065	90.592

Sample of 46 developing countries, 1980-2001

Table 2.5: Estimation Results: IV Approach

	OLS		2SLS[1]		2SLS-Probit[1]	
Variable	**Coefficient**	**(t-stat.)**	**Coefficient**	**(t-stat.)**	**Coefficient**	**(t-stat.)**
multipleXR	-2.188***	(4.58)	-4.511*	(1.71)	-0.737	(0.94)
usindprod	-0.035	(0.50)	-0.070	(0.93)	-0.060	(0.74)
ustrate	-0.389	(1.30)	-0.449	(1.48)	-0.488	(1.63)
ukindprod	-0.013	(0.16)	0.028	(0.30)	0.041	(0.43)
ukgovyield	0.564	(1.22)	0.688	(1.44)	0.738*	(1.74)
tot	-0.012	(1.15)	-0.007	(0.63)	-0.01	(0.97)
gap(-1)	-0.092	(0.90)	-0.116	(1.08)	-0.122**	(2.10)
domesticreturn(-1)	0.001	(0.34)	0.001	(0.37)	0.001	(0.15)
inflation(-1)	0.000	(0.45)	0.000	(0.04)	0.000	(0.04)
budbal(-1)	0.125**	(2.17)	0.165***	(2.62)	0.160**	(2.15)
openness(-1)	0.034***	(2.78)	0.023	(1.07)	0.030	(1.20)
civil	-0.031	(0.20)	0.082	(0.50)	0.086	(0.48)
nres_gdp(-1)	-0.044***	(2.71)	0.025	(0.35)	-0.004	(0.06)
crisisperyear(-1)	-1.544***	(2.67)	-1.967***	(2.85)	-2.121***	(3.69)
intercept	3.885	(0.58)	2.671	(0.33)	-1.612	(0.21)
F test (P-value)	0.000		0.000		0.000	
Observations	518		429		429	
Hansen OIR test (P-value)			0.124			

Significance levels : * : 10% ** : 5% *** : 1%

Absolute value of t-statistics are reported in parentheses. Robust standard errors have been computed.

[1] multipleXR instrumented with $manufimports_{t-1}, fuelimports_{t-1}, stdebt\_xdebt_{t-1}, currcomplt_{t-1}$.

Table 2.6: First Stage Regression of Instruments for Parallel Rates

Variable	**Coefficient**	**(t-stat.)**
usindprod	-0.009	(1.52)
ustrate	0.018	(0.69)
ukindprod	-0.009	(1.02)
ukgovyield	-0.016	(0.45)
tot	0.000	(0.52)
gap(-1)	0.002	(0.32)
domesticreturn(-1)	0.000	(1.37)
inflation(-1)	0.000	(1.39)
budbal(-1)	-0.003	(0.44)
openness(-1)	-0.006***	(6.85)
civil	-0.007	(0.45)
nres_gdp(-1)	0.016***	(3.84)
crisisperyear(-1)	0.054	(1.11)
currcomplt(-1)	0.002*	(1.90)
manufimports(-1)	0.003	(0.86)
fuelimports(-1)	-0.007*	(1.68)
stdebt_xdebt(-1)	-0.005**	(2.21)
intercept	2.196***	(2.94)
F-test for joint significance of instruments		
(P-value)	0.002	
Observations	429	

Significance levels : * : 10% ** : 5% *** : 1%

Absolute value of t-statistics are reported in parentheses.

Robust standard errors have been computed.

Table 2.7: 2SLS Regression with Leads and Lags of Multiple Exchange Rates

Variable	**Coefficient**	**(t-stat.)**
multipleXR	-50.800	(0.78)
multipleXR(+2)	-1.132	(0.43)
multipleXR(+1)	27.728	(0.77)
multipleXR(-1)	20.245	(0.66)
multipleXR(-2)	1.947	(0.86)
usindprod	-0.010	(0.07)
ustrate	-0.772	(1.26)
ukindprod	0.045	(0.26)
ukgovyield	1.356	(1.22)
tot	-0.021	(0.92)
gap(-1)	-0.057	(0.35)
domesticreturn(-1)	0.017	(0.72)
inflation(-1)	-0.003	(0.73)
budbal(-1)	0.124	(0.92)
openness(-1)	0.026	(0.88)
civil(-1)	0.259	(0.58)
nres_gdp(-1)	0.103	(0.59)
crisisperyear	-1.655	(1.19)
intercept	-9.927	(0.66)
F-test (P-value)	0.001	
Observations	423	

Significance levels : * : 10% ** : 5% *** : 1%

Absolute value of t-statistics are reported in parentheses.

Robust standard errors have been computed.

Table 2.8: Estimation Results: DPD Approach

	Difference GMM		System GMM	
Variable	**Coefficient**	**(t-stat.)**	**Coefficient**	**(t-stat.)**
cf(-1)	0.262***	(3.50)	0.409***	(7.36)
usindprod	-0.190	(0.99)	-0.148	(0.78)
usindprod(-1)	0.105	(0.60)	0.089	(0.52)
ustrate	-0.219	(1.18)	-0.103	(0.52)
ustrate(-1)	-0.311	(0.64)	-0.163	(0.35)
ukindprod	-0.276	(1.01)	-0.346	(1.24)
ukindprod(-1)	0.242	(0.90)	0.337	(1.24)
ukgovyield	0.456	(1.22)	0.214	(0.61)
ukgovyield(-1)	-0.148	(0.16)	-0.244	(0.26)
tot	-0.020	(1.30)	-0.004	(0.20)
tot(-1)	0.005	(0.32)	-0.002	(0.17)
multipleXR	-2.271**	(2.37)	-1.857**	(2.58)
multipleXR(-1)	-0.421	(0.54)	0.444	(0.67)
gap	0.019	(0.11)	0.042	(0.25)
gap(-1)	-0.096	(1.05)	-0.136	(1.48)
domesticreturn	0.004**	(2.38)	0.003	(1.33)
domesticreturn(-1)	0.007**	(2.19)	0.003	(0.86)
inflation	-0.001	(1.47)	0.000	(0.53)
inflation(-1)	-0.001	(1.65)	0.000	(0.43)
budbal	0.065	(0.50)	0.095	(0.65)
budbal(-1)	-0.113	(0.86)	-0.029	(0.23)
openness	-0.006	(0.11)	-0.056	(0.76)
openness(-1)	0.107	(1.17)	0.069	(0.91)
civil	-0.167	(0.25)	-0.062	(0.10)
civil(-1)	-0.232	(0.32)	0.035	(0.05)
nres_gdp	0.030	(0.24)	0.049	(0.42)
nres_gdp(-1)	-0.096	(0.88)	-0.082	(0.71)
crisisperyear	-1.376***	(2.80)	-1.253**	(2.48)
crisisperyear(-1)	-1.650*	(1.99)	-0.814	(1.30)
intercept			10.842	(0.58)
F-test (P-value)	0.000		0.000	
m_1	0.017		0.008	
m_2	0.545		0.645	
Hansen OIR test (P-value)	1.000		1.000	
Observations	398		448	
Countries	42		45	

Significance levels : * : 10% ** : 5% *** : 1%

m_1 and m_2 are the P-values for the tests of no first and no second order serial correlation, respectively.

Absolute value of t-statistics are reported in parentheses. Robust standard errors have been computed

The instruments for each equation are:

Diff. GMM: $push^i_T, push^i_{T-1}, \ldots, push^i_1; tot^i_T, tot^i_{T-1}, \ldots, tot^i_1; cf^i_{t-2}, cf^i_{t-3}, \ldots, cf^i_1;$
$pull^i_{t-2}, pull^i_{t-3}, \ldots, pull^i_1$

Syst. GMM: *Diff. GMM instruments*, $\Delta push^i_{t-1}, \Delta tot^i_{t-1}, \Delta cf^i_{t-1}, \Delta pull^i_{t-1}$

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